UNITED STATES ARMY

MARCH 1971

AVIATION DIGEST

UNITED STATES ARMY AVIATION

DIRECTOR OF ARMY AVIATION, ACSFOR DEPARTMENT OF THE ARMY
BG William J. Maddox Jr.

COMMANDANT, U. S. ARMY AVIATION SCHOOL
MG Allen M. Burdett Jr.

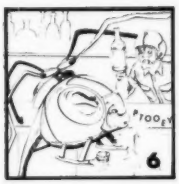
ASST COMDT, U. S. ARMY AVIATION SCHOOL
COL Hubert S. Campbell Jr.

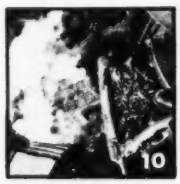
DIGEST STAFF
Richard K. Tierney, Editor
CPT Edward A. Bickel
2LT Kenneth G. Kitzmiller
2LT John H. Zwarensteyn
CW2 Mike Lopez
William H. Smith
Linda McGowan
Brenda R. Harp
Betty S. Wallace

GRAPHIC ARTS SUPPORT
Harry A. Pickel
Dorothy L. Crowley
Angela A. Akin

DIRECTOR, U. S. ARMY BOARD FOR AVIATION ACCIDENT RESEARCH
COL Eugene B. Conrad

USABAAR PUBLICATIONS AND GRAPHICS DIV
Pierce L. Wiggin, Chief
William E. Carter
Jack DeLoney
Ted Kontos
Charles Mabius
Patsy R. Thompson
Mary W. Windham





MARCH 1971 VOLUME 17 NUMBER 3

ARTICLES

S2 + CO + AMC = KO-VC 2
Doesn't Taste Like JP-4 6
New Landing Surface 8
They Need Us Down There 10
Turtle 14
MK-45 Aircraft Flare 16
IFR Apathy 20
Standardization 24
Rapid Refueling The CH-47 32
Fuel Exhaustion 36
UH-1 Crashworthy Fuel System 39
Baptism In Fire 43
Definition Of Orientation-Error Accidents 46
The Use Of Army Rotary Wing Mishap Experience To Assure Improved Product Effectiveness 49
PEARL'S 63
Recipe For The Month—How To Make A Crash Facts Message Back Cover

FEATURES

Views From Readers 1
Charlie And Danny's Write-In 18
Instrument Corner 27
Aeromedic—Weight And Balance 28
USAASO Sez 64

ABOUT THE COVER

A UH-1 helicopter supports elements of the 1st Cavalry Division (Airmobile) in operations in the Republic of Vietnam. The value of such aviation support is discussed in the article "They Need Us Down There" beginning on page 10. The cover photo is by SP4 James McCable

The mission of the U. S. ARMY AVIATION DIGEST is to provide information of an operational or functional nature concerning safety and aircraft accident prevention, training, maintenance, operations, research and development, aviation medicine, and other related data.

The DIGEST is an official Department of the Army periodical published monthly under the supervision of the Commandant, U. S. Army Aviation School. Views expressed herein are not necessarily those of Department of the Army or the U. S. Army Aviation School. Photos are U. S. Army unless otherwise specified. Material may be reprinted provided credit is given to the DIGEST and to the author, unless otherwise indicated.

Articles, photos, and items of interest on Army aviation are invited. Direct communication is authorized to: Editor, U. S. Army Aviation Digest, Fort Rucker, Ala. 36360.

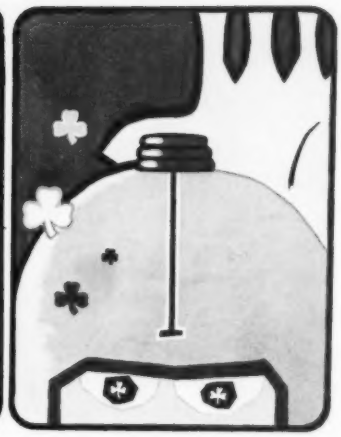
Use of funds for printing this publication has been approved by Headquarters, Department of the Army, 1 October 1970.

Active Army units receive distribution under the pinpoint distribution system as outlined in AR 310-1. Complete DA Form 12-4 and send directly to CO, AG Publications Center, 2800 Eastern Boulevard, Baltimore, Md. 21220. For any change in distribution requirements, initiate a revised DA Form 12-4.

National Guard and Army Reserve units under pinpoint distribution also should submit DA Form 12-4. Other National Guard units should submit requests through their state adjutants generals.

For those not eligible for official distribution or who desire personal copies of the DIGEST, paid subscriptions, $4.50 domestic and $5.50 overseas, are available from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402.

VIEWS FROM READERS



Sir:

It's time to say goodby to an old girl who did an outstanding job for Army aviation for 15 or 16 years, plus or minus 1 or 2, and is still doing a fine job for the Army National Guard aviation units.

I remember the first time I saw the Mojave was when I reported in for CH-37 transition training at Ft. Sill, Okla., in June 1964. I reflected that it would be impossible for something so big with sling wings to actually fly under its own power. But on my "dollar" ride I was in for a great surprise; not only could it do things other sling wings could do, it could actually do them on one of its two R-2800 engines!

During the 4-week transition course I was taught how to land on slopes, to autorotate and all the other things normally taught in a transition course. I was beat upon the head and shoulders severely if I exceeded 2700 rpm and 57.5 inches of manifold pressure. When I left Ft. Sill there was no doubt that the CH-37 Mojave was a fine helicopter and would be around for many years.

Never have I heard a kind word for the Mojave from nonqualified CH-37 aviators. We who flew her in the Republic of Vietnam know what she would do. She grunted and groaned when you latched onto a CH-34 or UH-1 in a rice paddy, but she did her job well. A few times we had to go to 3,000 rpm and 70 inches of manifold pressure yet she never complained. I worked with her again in the Republic of Korea in the summer of 1967, escorting her through the sky from Pusan in the south to Panmunjom in the north and she never failed me once.

Now she is being retired from the rice paddies of Vietnam and the mountains of Korea, as well as the plains of Germany. I think the only active Army CH-37 is at Ft. Rucker, Ala. So, let me say *three cheers for the Mojave!* She performed her job well for many years and I hope that her memory and prestige are carried on in the Guard. Many of us will remember her well with warm and kind thoughts.

CW3 Gerald R. Meador
120th AHC
APO San Francisco 96201

• Since you wrote the last of Ft. Rucker's CH-37s also have been retired. However, one went to the U. S. Army Aviation Museum at Ft. Rucker where it will soon be on display. The museum's hours are from 0900 to 1600 weekdays and 1300 to 1700 weekends and holidays; it is closed only on Christmas day. Your letter reflects our sentiments and all we can add is PROSIT!

★ ★ ★

Sir:

I am writing in reference the "Aeromedic" section of the October 1970 AVIATION DIGEST. I am in full agreement with the account of the superior qualities of the SPH-4 helmet; however, I must take exception to one statement, "Over 35,000 copies of this advanced design have been procured for Army aviation, enough for everyone."

Here at Ft. Wolters the SPH-4 helmets are issued only to the *student* pilots while permanent party aviators must use the old APH-5 helmet. This is a particular source of irritation to the instructor pilots who are constantly exposed to the factors the SPH-4 is designed to lessen. The only way a rated aviator can get an SPH-4 on this post is to obtain such a low rating on his hearing test that the flight surgeon considers it necessary for him to wear the SPH-4 as a corrective device.

If enough helmets have been produced so that every Army aviator may have one, I should like to know why approximately 1,900 rated aviators at Ft. Wolters are allowed to wear only the older, less efficient APH-5 helmet. I should also like to know by what method and priority the Army distributes new equipment such as the SPH-4.

CW2 Charles H. Ambrosi
Aviation Training Branch
DPT-SEC
Ft. Wolters, Tex. 76067

★ ★ ★

• It was not intended to imply in the October 1970 AVIATION DIGEST that there were enough helmets for everyone. A check with the Troop Support Division, U. S. Army Materiel Command, reveals there were 42,000 helmets procured on an expedited basis in order to provide Army flight personnel with the greatest degree of protection available today. However, this quantity falls short of the amount actually required to provide all authorized Army aviators and crewmen with SPH-4 helmets.

To deal with this shortage, AMC says that a priority system was established for the distribution of helmets to Army personnel. First priority is Southeast Asia and, of course, this area also required the largest number of helmets from this procurement. Second priority covers student training, both at Ft. Wolters, Tex., and Ft. Rucker, Ala. The third priority makes allowances for all those individuals deploying to SEA or those recommended by a flight surgeon for medical reasons.

AMC is working in close coordination with the Defense Supply Agency in attempting to procure a sufficient supply within an expedited time frame so that all authorized Army personnel may soon be issued the SPH-4 helmet.

S2 + CO + AMC

We all know how effective intelligence information can be, but where does it come from? Your man with the news is the S2. He spends a great deal of time piecing together bits of trivia, each little bit adding to the total picture. The author suggests a useful formula . . . take a commanding officer, add intelligence information from the S2 and support from the air mission commander, and you can deliver a knockout punch against any enemy

Lieutenant William R. Glazner

IT WAS ABOUT 0700 hours and nine slicks of the 347th Assault Helicopter Company departed home base to pick up a company of the 1/76 Infantry. They would be working in an area that most of the pilots classified as dead area because it had been worked over and would probably contain no enemy. For some reason unknown to the aviators the infantry battalion S-2 indicated that there was a 10 to 15 man element located in the neighborhood of a small "friendly" village.

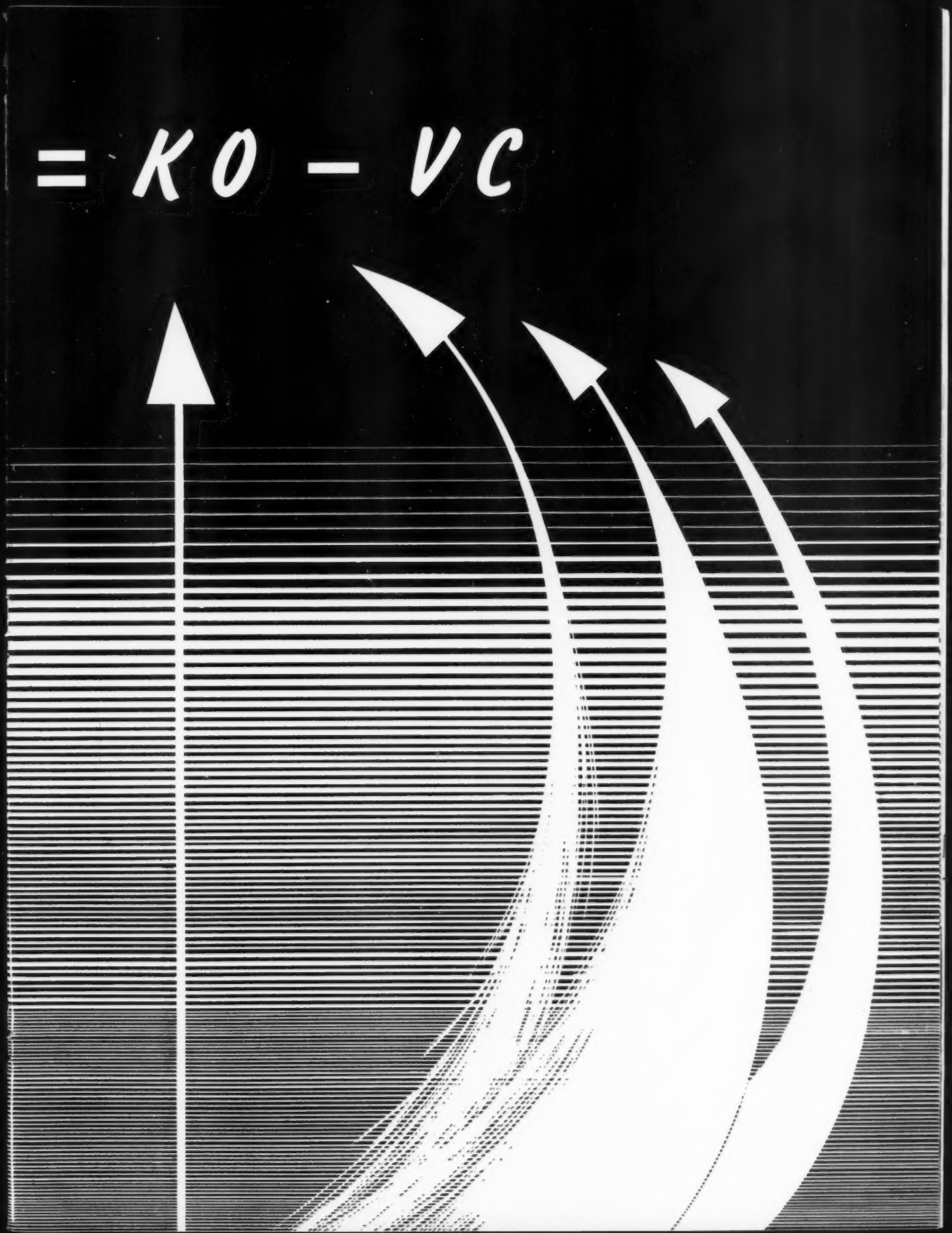
The aviators were unmoved by the mission. There was a feeling that the mission would be unproductive; however, a boring mission with no enemy contact would be a nice change considering the high percentages of contact the unit had encountered during the past few months.

During the mission commander's briefing the S-2's report of enemy activity was discussed. It seemed that there wasn't anything the S-2 didn't know about that 10 to 15 man group the infantry was pursuing. He had said they were members of a commo liaison unit and that the most we would be up against were 12 men and three women. Of these 15 there were three classified as high ranking Viet Cong (VC). The S-2 knew the names of the VC, the weapons they carried and their physical descriptions. He even had three pictures which he identified as those of three of the high ranking VC. The mission commander had to admit the S-2's story was interesting; however, he personally couldn't believe it and felt that any contact in that area would be highly unlikely. The S-2 also mentioned that even though the enemy had no weapons other than small arms, the aircraft would probably receive ground fire.

The pickup of the ground element came off smoothly. The landing zone (LZ) was about 8 minutes out and all the aviators made necessary preparations, mental and physical, for the troop insertion. The LZ was marked and the troops offloaded without incident. The pilots were thankful that the S-2 had been wrong about ground fire.

As flight lead departed he observed three armed individuals running from the village and notified the command and control (C&C) helicopter. One of the supporting gunship pilots made a low pass to check out these individuals and received a burst of small arms fire. He immediately returned fire and reported he had at least wounded all of the enemy.

The ground element began receiving heavy small arms fire from a house 200 meters west of the LZ. Gunship cover was requested and the


= KO - VC

guns suppressed the small arms fire. In a period of 3 to 4 minutes the heavy contact had subsided to sporadic fire. Forty-five minutes later the ground element had secured the area and was ready for pickup.

As the Hueys completed the pickup and returned the infantry company to its fire support base, the mission commander informed the pilots of the results of the mission. Of the three enemy engaged in the operation, two were killed and one was wounded. The house contained eight males and two females. Six of the male occupants were killed and the rest captured. In the surrounding area the ground element had located two more guerrillas-one male and one female who resisted and subsequently were killed. The total was 10 enemy killed and five captured. Twelve assault rifles and three 9 mm pistols also were captured. After the infantry had been dropped off and the C&C ship was headed for its next mission, the air mission commander begin to wonder how the S-2 had known so much about that 15 man enemy element.

That evening the main topic of discussion was the surprising results of the morning mission. The general desire of all the members of the 347th was to contact the infantry S-2 to find out where and how he obtained the information about the village.

The following afternoon the assault company mission commander and flight lead found themselves in a meeting with the infantry battalion intelligence officer.

The S-2 began his briefing on how combat intelligence works. The concept of the previous morning's mission had been developing over a 2 month period. The first information had come from a VC captured by an ambush patrol more than 8 kilometers from the actual operation. The prisoner of war (PW) had stated he was a member of a 16 man commo liaison unit. He subsequently gave the names, descriptions and type weapons carried by the members of his unit. He also stated there were three women in the unit. It was learned that the unit stayed at a certain house each day, moving into the area about 0400 hours and leaving around 1200 hours.

The PW was new in the area and did not know the exact location; however, he did know that it was the home of a fellow VC by the name of Duc. A check of the battalion intelligence files revealed there was a VC named Nyugen Van Duc who was a member of a local commo liaison unit.

Coordination with Republic of Vietnam agencies revealed where Duc lived. A photo mission

of the area enabled the PW to identify the house. All adjacent agencies that had agent nets were queried for information on enemy activity in the targeted area.

The following week one of the agencies reported that about 10 men came to one house every night. The aerial photos were turned over to that agency and the source identified the same location the PW had. By this time it seemed apparent that the intelligence was accurate and a mission should be run; however, the commander requested more information. He wanted to know if the enemy element could be ambushed or should a combat assault be used.

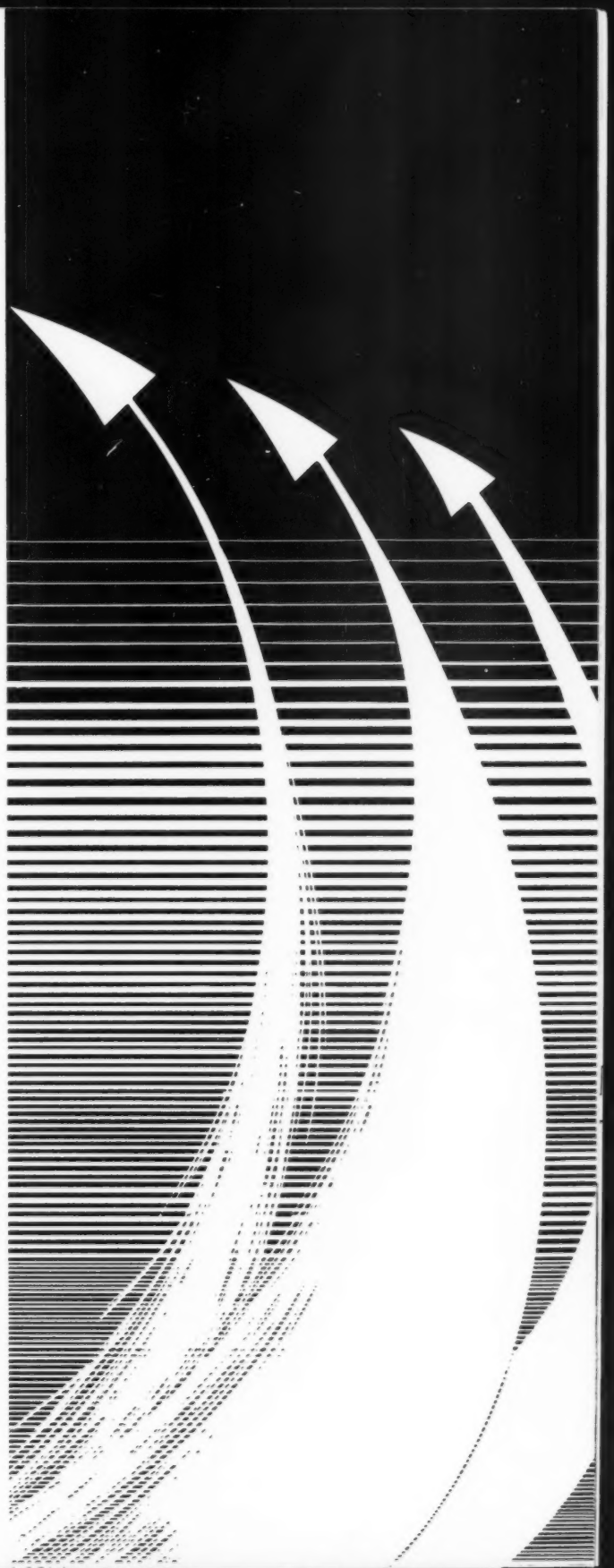
To gather the information the commander wanted, a long range reconnaissance patrol team was put into the area for 5 days and nights. They discovered that the unit entered the area between 0200 hours and 0400 hours each night in three groups using any combination of five different routes. They also reported that four to six people were posted as guards while the others stayed in the house. Over the 5 day period the strength of the unit varied from 10 to 15 people. With this information the commander decided on a combat assault with a company size element.

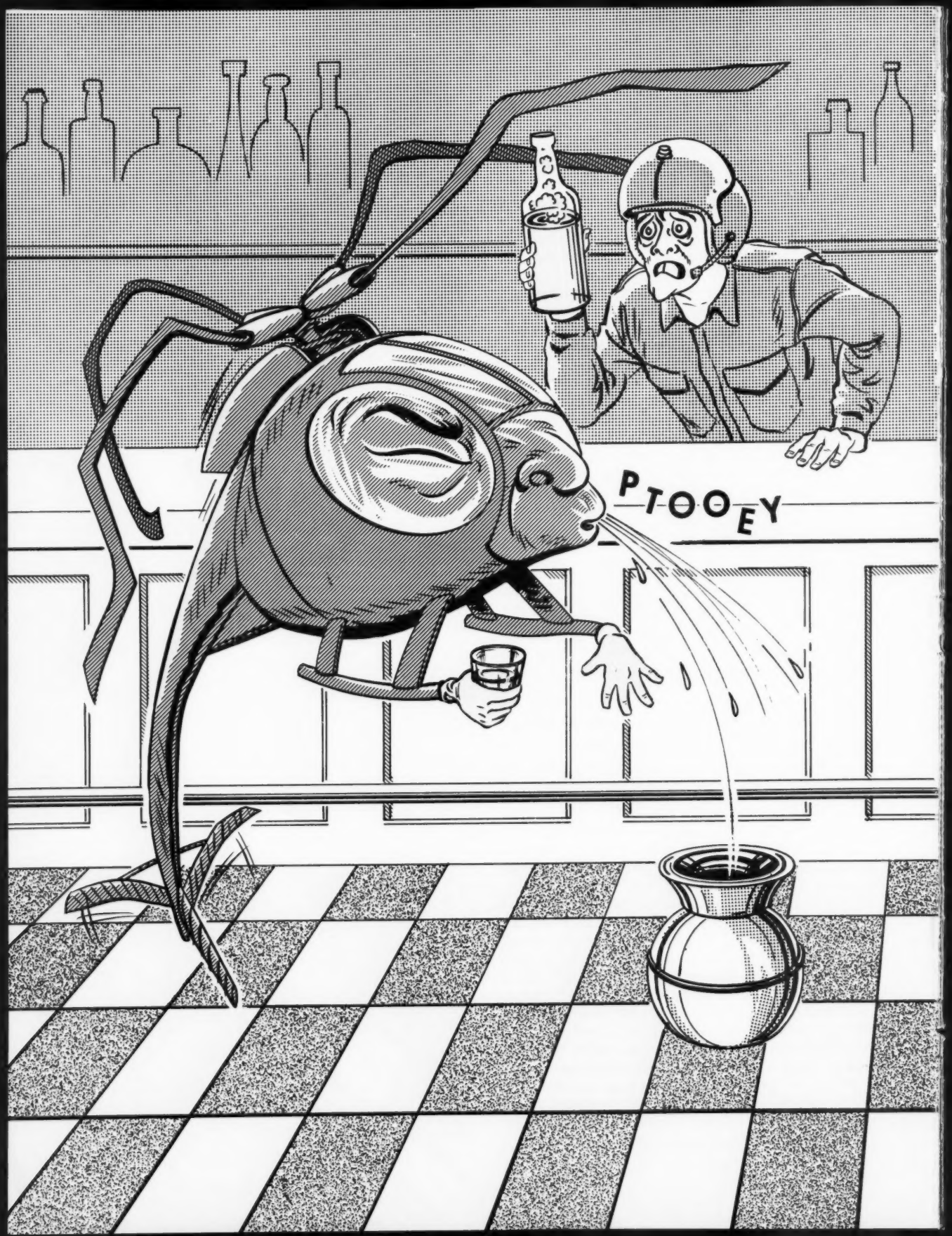
The aviators were quite impressed by the S-2's briefing. However, the S-2 warned them that sometimes good intelligence does not produce the desired effect in an operation. He pointed out that all missions face the possibility of being turned into a dry hole. Even with information that has been confirmed and cross-checked, there is that chance that the enemy could be tipped off. In this case he would simply change his routine and the mission would have negative results.

The S-2 was asked if the number of agencies used to develop this mission was typical. He replied that often quite a few more were approached in an intelligence operation but it is rare for so many different agencies to confirm and support the intelligence as well as in this case.

Finally the S-2 was asked if there was any way that aviators could improve their support of intelligence operations. The intelligence officer expressed his desire for coordination and discussions much like the one they were having. He stated that with any operation the S-2 and S-3 of the ground element should brief the supporting aviation unit as fully as possible. If the unit feels underbriefed, it should make it known and strive to obtain all the information possible.

When the meeting had come to an end both elements left with a better understanding of the other's mission.




PTOOEY

Doesn't Taste Like JP-4

make sure that what you see is what you want

Captain G. A. Renn

THE SCOUT TEAM took off that morning for its first light visual reconnaissance (VR). The specific mission was to check out side looking airborne radar (SLAR) readings gained from VRs the preceding night.

The first 2 hours of the search revealed nothing during low sweeps in an OH-6A Cayuse. The AH-1G HueyCobra pilots continued their watch from above, ready to react when the enemy was found. Then when it seemed the enemy was not to be found, the LOH took fire. The crew chief and the observer returned the fire and smoke was thrown to mark the position for the Cobras.

As the Cobra pilots made their passes, they realized that a large enemy force had been uncovered. They radioed for support and another team of Cobras soon arrived and was briefed. The first team then broke station to refuel and rearm.

The closest resupply facility was a fire base several kilometers away. Its POL facility was a bomb cratered slope and the aircraft were serviced from 500-gallon blivets.

When the first team arrived at the refueling point, the Cobras were able to be landed on level positions; however, the LOH pilot was forced to land on only one skid.

As the situation in the contact area continued to develop, the "Blues" (the air cavalry troop's organic rifle platoon) were loaded aboard slicks to be inserted to set up a blocking force and attempt to capture prisoners.

As the battle continued the first team once again exhausted its fuel load. Again the LOH was forced to hover on the slope as the crew chief jumped out to service the ship. Anxious to get the ship refueled as soon as possible, he recruited a man to refuel the ship while he prepared more ammunition for his M-60. The crew chief saw that all the bladders in the POL were marked JP-4, so he instructed his recruit on how to refuel the helicopter then busied himself with rearming.

Just as the refueling was completed and the crew chief was strapping himself in, the engine failed and pilot was forced to make a hovering autorotation on the dangerous slope. Fortunately, the pilot was able to execute the autorotation successfully.

The crew chief, immediately realizing what might have happened but hoping that it really hadn't, went to the bladder that had been used to refuel the ship and tasted its contents. Much to his dismay he found that the ship had, in fact, been refueled with water.

The crew chief was then faced with several courses of action:

- He could go AWOL.
- He could defect.
- He could murder his helper.
- He could drain the tanks and notify maintenance.
- He could cry.

After some quick consideration of the alternatives, he drained the fuel tanks and began to read chapter 3 (inspection procedures) of his dash 20 while waiting for maintenance.

One very important lesson was learned by all concerned: You can't always tell what's in a package by its wrapping. Although the bladder was clearly marked JP-4, it obviously contained something quite different. Mistakes can and have been made many times in the rear trains areas. Bladders, for instance, can be filled with anything that can be pumped into them.

Above, one of the giant tacks used to nail down the new airfield membrane material is being hammered into the ground. The membrane, a new material designed for use on forward landing strips, is being tested at Ft. Bragg's Falcon Strip. Left, a grader trims the edge of the 3,700 foot runway. Right, a liquid adhesive is applied to overlapping sections of the membrane. The adhesive is applied to the material to prevent moisture from gathering between the membrane and ground. Far right, the finishing touch is applied to the new material

XU

New Landing Surface

ENGINEERING and service tests of a new membrane material for use in surfacing military landing strips got under way recently at Falcon Strip, Ft. Bragg, N. C.

A 3,700-foot landing strip and associated turn-around facilities were covered with the new, heavy-duty material by Army combat engineers from Ft. Bragg. The unit consisted of a platoon from Company "C" and other troops of the 47th Airborne Combat Engineer Battalion. This unit will maintain the airfield throughout the conduct of the test, which is expected to end this June.

For test purposes, the soil underneath the membrane was prepared to meet the standards of a Type III runway, the most sophisticated of the three types of tactical assault landing strips. These and other detailed subgrade preparations were completed by troops from Company "C" of the 548th Construction Engineer Battalion.

The membrane and associated equipment arrived at Ft. Bragg in November after lengthy development effort by the U. S. Army Waterways Experiment Station at Vicksburg, Miss.

Engineering tests of the airfield membrane are being conducted by personnel from the U. S. Army General Equipment Test Activity of Ft. Lee, Va., and Army service tests are being conducted by the Armor and Engineer Board of Ft. Knox, Ky. Both organizations are subordinate agencies of the U. S. Army Test and Evaluation Command.

The testing will include landings and takeoffs by a variety of both fixed and rotary wing aircraft. Among them will be Air Force C-130 aircraft loaded with cargo of various weights. Aircraft support for the tests will be furnished by the Replacement Training Unit of the 464th Tactical Airlift Wing of Pope Air Force Base, N. C.

In addition to landings and takeoffs, the aircraft will perform maneuvers such as locked-wheel braking and locked-wheel turns to determine if the material will stand up under all conditions.

The airfield membrane is made of a four-ply nylon fabric impregnated with neoprene, a synthetic rubber characterized by a high resistance to oil, gasoline, sunlight and adverse weather. The membrane is issued in sections with dimensions of 53 by 66 feet, and can be easily unloaded and rapidly installed over any relatively smooth prepared surface. The membrane is attached to the ground with large tacks specially designed for that purpose.

To prevent moisture from forming between the membrane and the subgrade, a liquid adhesive is used to seal the material where the sections meet and where tacks have been driven in.

The membrane has been installed on the highly prepared subgrade for test purposes only. It was designed to be used in forward areas where permanent airfields would be impractical and where there is a need for the rapid deployment of a landing strip.

The mission of Army aviation is support. Those who are "Above The Best" can only maintain that laudable position by remembering . . .

They Need Us Down There

Major John A. Little

ARMY AVIATION has but one purpose: support of the infantry soldier. Few will debate the loyalty, dedication and professionalism of most Army aviators in accomplishing this mission, and the following story justifies these beliefs.

On 6 March 1969 Company A, 12th Cavalry, 1st Cavalry Division (Airmobile) met heavy enemy resistance in a bunker complex northeast of Bien Hoa, Republic of Vietnam. The battalion commander decided to take Company C and conduct a combat assault into an area south of Company A.

Six transport helicopters from A Company and two AH-1G HueyCobra gunships from D Company, 227th Assault Helicopter Battalion were assigned to the combat assault.

Following artillery and rocket preparation, the initial lift of three transport helicopters deposited 18 infantrymen in the small clearing. Two more UH-1Hs landed after the initial lift was clear of the landing zone (LZ)—the sixth transport helicopter developed maintenance problems and was forced to land at another fire base. A total of 30 infantrymen were now in the small LZ.

Since Yellow 1, the flight commander, felt the LZ was now secure he directed the transport helicopters to proceed as single aircraft instead of in a flight. This procedure is used when lifting troops from one secure point to another since it allows for quicker turn-around time and reduces the chance of an accident in a tight LZ.

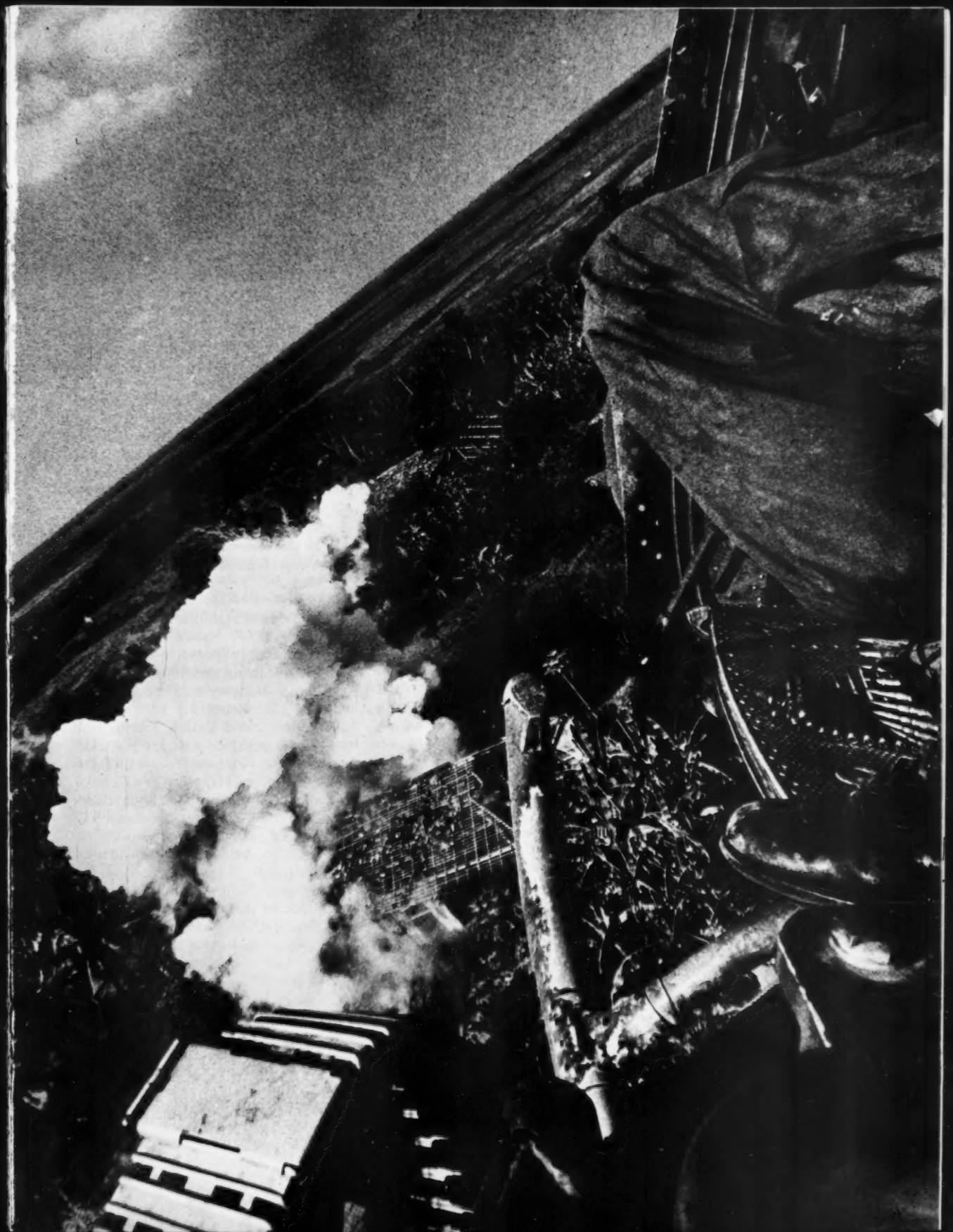
As Yellow 1 approached with the sixth sortie, he was suddenly engaged by a tremendous volume of small arms, automatic weapon and antiaircraft fire. Simultaneously the troops on the ground received intense direct and indirect fire, including rocket propelled grenade rounds. Immediately the two gunships raked the tree line with rockets, 40 mm grenades and minigun fire.

Yellow 1 was forced to abort his approach due to extensive damage to his aircraft. The fire team leader of the Cobra gunships was notified by the troops in the LZ that the enemy was emplaced in heavily fortified bunker positions with 3 to 4 feet of overhead cover. Two of the bunker positions contained .50 caliber antiaircraft machine guns.

Additional Cobra gunships were scrambled from Lai Khe, as well as a request for more aerial rocket artillery sections, and a request for an immediate tactical air strike. The battalion commander of the 227th directed more transport helicopters into the area. Meanwhile, the gunships on station kept the enemy from overrunning the LZ

There were now seven gunships on station over the LZ. Yellow 1, having taken command of another transport helicopter, again attempted to insert the badly needed sixth sortie of reinforcement.

Two Cobras, flying low level and slightly ahead of Yellow 1,



A UH-1 Huey medevac ship stands ready

placed continuous suppressive fire along the route. Simultaneously another Cobra fire team placed rocket and minigun fire along the southern part of the LZ to suppress the .50 caliber antiaircraft machine guns.

Due to the haze and smoke from the battle, the small LZ became obscured and Yellow 1 overshot it.

Immediately another gunship dropped down over the LZ and at 200 feet made tight pedal turns with the navigation lights on "bright flash." Another approach was made by Yellow 1 using the gunship as a guide.

The volume of ground fire was so intense that Yellow 1 again was forced to abort.

While marking the LZ the lone Cobra crew noted that the rockets were not penetrating the heavily reinforced bunkers. In addition, smoke could not be used as it would completely obscure the LZ.

By this time there were about 40 aircraft involved in the operation.

An air strike was put in just south of the LZ, but the enemy bunkers and positions along the southern edge were not affected. Wounded troops could be seen laying in the area just too close for an air strike.

Gunships of D Company started making low level runs in an attempt to place minigun and 40 mm grenade fire into the bunker firing ports, and flechette rockets were fired near the friendly troops.

Yellow 1 was now back on station northeast of the LZ in his third aircraft. The gunship commander, realizing that the rockets were not affecting the bunkers, directed three sections of aerial rocket artillery to make continuous, high-speed dive attacks on the southern edge of the LZ. Simultaneously two light fire teams from D Company, flying low level, escorted Yellow 1 in for another attempt to land. The same Cobra, with navigation lights still on "bright flash," orbited in tight pedal turns to guide Yellow 1.

The copilot was able to observe the bunkers and place 40 mm grenade fire on them. At the same time the aerial rocket artillery Cobras were directed to place their 17-pound warhead rockets on the flashes made by the explosions of the grenades. In this manner several automatic weapon positions were neutralized.

Yellow 1 proceeded through the dense smoke and intense ground fire, accompanied by constant suppressive fire from the escorting gunships. Yellow 1 flared suddenly and dropped into the LZ. Repeating this method Yellow 2 and Yellow 3 landed.

The gunships and aerial rocket artillery continued to pound the enemy positions. Yellow 4 started his approach but overflew the LZ. Though extensively riddled with automatic weapon fire, he landed on the second approach. Six more men on the ground! Yellow 5 and Yellow 6 inserted the eighth and ninth sorties. Both aircraft, however, sustained such extensive damage they were immediately grounded at a nearby fire base.

It was starting to get dark, but tracers from automatic weapons and a series of flaming "basketballs" from a .50 caliber machine gun continued to reach out at the low flying gunships. A total of six transport helicopters

from the 227th were so extensively damaged that they were grounded at nearby fire bases. Maintenance crews would work far into the night rigging and slinging these aircraft out to maintenance facilities.

Several sections of aerial rocket artillery expended their ordnance on the enemy positions, and Yellow 4 volunteered to attempt to evacuate the wounded. Led by the gunship commander, who again marked the LZ, and escorted by two Cobra fire teams, Yellow 4 began his approach. His aircraft and crew were constantly jarred by the impact of devastating ground fire. Seeing the wounded lying in the LZ, Yellow 4 refused to abort his approach.

As he set his aircraft on the ground, the windshield disintegrated from the impact of .30 caliber machine gun rounds fired from about 40 meters to their front. Six infantrymen jumped off the aircraft to reinforce the LZ and, in spite of the urging of the commander, Yellow 4 refused to depart until the wounded were all on board.

Tracers continued to thrash the LZ, impacting in and around Yellow 4. One of the wounded, while being lifted into the aircraft by the crew chief, was killed instantly by a round in the head. The doorgunner was wounded in the foot. Six wounded were on board when the aircraft limped out of the LZ and clawed for altitude.

During the entire period the gunship commander hovered his aircraft 200 feet above, allowing his copilot to rake the enemy with minigun and 40 mm grenade fire. In spite of this cover Yellow 4's aircraft sustained in excess of 40 hits, including .50 caliber rounds embedded in the engine, transmission and rotor mast.

Yellow 4 coaxed his aircraft to a nearby fire base 8 kilometers from the LZ and autorotated safely to the ground.

Although it was now dark, the mission was not complete. The gunships of Company D continued to deliver direct fire support. An ammunition resupply was needed.

Another transport crew volunteered to take the load in. In spite of the still heavy ground fire this aircraft hovered in and kicked out the direly needed ammuntion to a trip flare ignited in the LZ.

Gunships of Company D stayed on station until 2030 hours delivering fire on enemy positions. The LZ was now secure.

During the 6-hour battle over 40 aircraft flew in support of the operation. Adequate reinforcements and decimation of the enemy by aerial firepower enabled the infantry to secure the LZ without any further casualties.

Seven aircraft of the 227th were extensively damaged—two required evacuation to the United States to be rebuilt, while the other five required 2,200 man-hours to repair. Over 1,300 aerial rockets and 38,600 rounds of minigun ammunition were expended.

The determination of the aviators and their crews to accomplish the mission, regardless of the cost, never waivered. The infantryman had been supported.

"Six more men on the ground!"

TURTLE

Although not textbook answers, CPT David W. Owen has captured in the following article a classic reflection on the Vietnam conflict. Our thanks to MAJ William F. Gabella for forwarding it to us

Captain David W. Owen

TURTLE FLIES helicopters, light observation helicopters specifically. His parents call him John, but to the officers of the Americal Division's F Troop, 8th Cavalry (Blueghost) Warrant Officer John S. McRae is known affectionately as Turtle. The origin of his nickname is obscure although a turtle is generally the pseudonym for a replacement or new guy in the Republic of Vietnam.

For the name to have stuck with WO McRae over the months is paradoxical since turtles are generally slow moving, passive, defenseless little creatures—everything an LOH pilot isn't. Actually, no turtle in his right mind would fly an LOH—except the Blueghost's Turtle, of course.

When WO McRae was interviewed about his job as scout pilot in an air cavalry troop. His answers provide a real insight into the kind of man who flies the small OH-6 helicopter at treetop level through enemy-infested areas.

"Turtle, what is it that you like about being a scout? Is it the challenge of the battle of man against man? The matching of wits and cunning with the winner taking all?"

"No. Actually, it's the days off. We scouts get more days off than the other platoon."

"When you're down there low level, Turtle, flying at 100 knots, what are you looking for? Is it trails, hootches, fighting positions or what?"

"Mostly I'm looking for an excuse to come up to altitude and go back to Chu Lai."

"Turtle, what is the biggest hazard to you while you're down there on the deck? Is it the AK-47 fire, .30 caliber machine guns or .51 caliber fire? What do you fear the most?"

"Trees. Tall, thin, dead trees. They'll get you every time."

"It's hard to believe that you worry more about trees than NVA, Turtle. How about your observer and door gunner? Besides their obvious duties of trying to spot the enemy and signs of activity, what are their secondary jobs. Just what else does the observer do?"

"He prays. From the time we take off until we land. And it's not his secondary job either. It's his primary."

"And what about the door gunner?"

"Mostly he just screams, 'Taking fire! Look out! Watch that tree! We're hit!' He prays a lot too."

"Here's a question that will probably require a little thought. To date what has been your most significant sighting as a scout pilot?"

"That's easy. A beautiful girl taking a bath in the Song Ve River."

"No, Turtle. What was your most significant military sighting as a scout?"

"A beautiful girl taking a bath in the Song Ve River. She was an NVA nurse."

"Did you capture her?"

"No, I hit a tree and had to go back to Quang Ngai."

"Turtle, do you have any big operations coming up in the near future? What are you looking forward to in the next month or so?"

"The monsoons. We don't fly much in the monsoons."

"Last question, Turtle. What do you remember as your most gratifying experience as a scout?"

"It was during the battle of Hiep Duc. There were .51 cals all over and beaucoup .30s and AKs. They were even shooting RPGs at choppers. The air mission commander had just told me to go down and do my thing when my high engine oil pressure light came on and I had to go back to Chu Lai. Now that was a gratifying experience."

If the whole truth were known, Turtle did go back to Chu Lai but only to get a replacement aircraft in which he returned to Hiep Duc and did his thing much to the dismay of many of the NVA who were roaming the Que Son Valley at the time.

Although they may not be textbook responses, Turtle's answers do reflect one of the qualities a good scout pilot must have in order to survive in his dangerous business. In a moment of serious contemplation Turtle put his finger on it, "There's an old saying among scouts that there's two things you can't afford to lose while flying scouts—your sense of humor and your main rotor." Turtle's face brightened immediately, "Of course, being a practical man and given a choice, I'd rather lose my sense of humor!"

MK-45 Aircraft Flare

Captain Christopher D. Garbow

The MK-45 aircraft flare, incorporating many safety and operational improvements over the MK-24, is now in limited use in the field. It boasts up to 2 million candlepower, enough to light an area that ranges up to 3,500 meters in diameter

A NEW FLARE, the MK-45, has recently been introduced to replace the MK-24. Many significant improvements have been made, principally in the area of safety and simplicity of operation.

The MK-45 provides illumination upwards of 2 million candlepower and will light an area 3,500 meters in diameter. Burning time is an average 3½ minutes and during that time the flare will descend about 1,575 feet. The flare will, of course, give off more light with a cloud cover than in fog or haze.

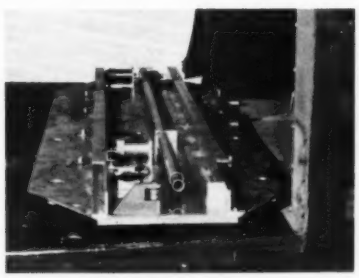
The flare's outer cover is a lightweight aluminum tube, 33¼ inches long and 4.87 inches in diameter. The tube houses all the main components of the flare starting with the fuze assembly and followed by the candle, suspension, ignition and parachute assemblies.The weight of the MK-45 is 28 pounds. Protruding about 2¼ inches beyond the end of the tube is a part of the fuze protected by a shipping cap. Inside the cap is stored the lanyard assembly. This extension makes the overall length of the flare 36 inches.

The new flare is used in the XM-19 flare dispenser. The dispenser is made of lightweight aluminum tubing and will hold 24 flares and weighs 850 pounds loaded and 180 pounds empty. The dispenser is attached to a jettison plate which in the UH-1 is mounted to the cargo floor directly behind the pilot compartment.

In operation the fuze on the MK-45 is normally set before takeoff, but may be set immediately before launch. The fuze setting mechanism is a single yellow dial indicator which is set in feet of fall. There is no need to convert seconds to feet as is the case with the MK-24. The dial indicator can be set at 15 different positions ranging from 500 to 14,000 feet, which allows fuze settings in 1,000-foot increments except for the minimum setting of 500 feet.

To launch the flare the safety pin is removed, the dispensing gate is unlocked and the flare is moved into position. The flare is then launched by pushing the fuze end in the direction of the cam so that upon release the pull cable slides quickly down the snout and the base of the flare is pulled free of the dispensing foot. Or, the MK-45 can be hand launched by removing it from the dispenser and attaching the lanyard to a 4-foot static line.

When the flare is launched, ejection delay begins with the



breaking of the shear pin. During the delay the candle and parachute remain inside the tube while the flare falls the distance set. At the proper distance the candle and parachute are ejected from the tube and ignition occurs. After the candle and parachute are ejected, the aluminum canister falls to the ground. For this reason it is not advisable to launch the flare over friendly troops.

In addition, the entire XM-19 flare dispenser may be jettisoned if necessary. Power to jettison the dispenser is provided by a nitrogen bottle which is activated electrically by a hand generator similar to the one used with the claymore mine. No power is required from the aircraft. When the hand generator is activated, the XM-19 and all flares will be jettisoned out the right cargo door in eight-tenths of a second.

There are three new safety precautions incorporated into the MK-45 flare: the fuze dial safe setting, the safety pin and the shear pin.

The first safety, the fuze safe setting, has already been discussed; the second, the safety pin, is left installed until just before the flare is launched. If the pull cable is inadvertently pulled with the safety pin in place, the pull cable will break instead of the safety pin. The final safety, the shear pin, is broken by the action of the pull cable on the snout and cam assembly. Furthermore, to keep an aircraft from flying into expended flares still drifting, the MK-45 has two explosive bolts which cut half the parachute shroud lines at the end of the burning cycle (3½ minutes). This collapses the chute and the expended flare falls to the ground.

Maintenance of the new flare is limited to cleaning, repainting and remarking of the flare and the inner and outer packing containers. The flares must be protected from mud, sand, moisture, grease and other foreign matter. Flares that are wet or dirty should be wiped clean and allowed to dry before repacking or loading.

Transportation of the MK-45 must be done in compliance with all requirements for hazardous material as contained in commercial and government regulations. Most transportation modes may be used provided the flare is not allowed to fall more than 5 feet.

The MK-45 aircraft flare is a vast improvement over the older MK-24. The XM-19 flare dispenser is now in production and the flare is already in limited use in the field.

Charlie and Danny's Write-In

DEAR DANNY: Recently I received change 4 to TM 55-1520-209-CL and change 10 to corresponding dash 10. My question deals with the new emergency steps accomplished during dual AC generator failure. Why is the reader led to believe that he can retract his longitudinal cyclic speed trim while operating on "battery only" power? The speed trim actuators operate from the 28V D.C. secondary bus and this is disabled with the loss of both transformer rectifiers which occurs with dual A.C. generator failure. Battery switch position would make no difference. Please set the record straight.

LT Confused

Danny's answer: Ah! The eagle eye of youth. Your question has brought considerable manual review with the result that Danny is in agreement with you. TM 55-1520-209-10, chapter 4, paragraph 4-106 states that "it will not be possible to power the 28-volt D.C. secondary bus since the bus tie relay will be deenergized with the failure of both transformer-rectifiers." Steps are being taken to correct this discrepancy in the manual.

Dear Danny: In reviewing my TM 55-1520-217-10/1, in chapter 2, I noticed it gives the outside dimensions of the pod, but not the interior. Can this be put in the manual? I sure could use this information.

CW3 G. B. D.

Danny's answer: The next change to your manual, which is due out shortly, will contain the information you requested. It will also be included in the 54B manual.

Dear Danny: TM 55-1510-204-10/2 (OV-1A) calls out a gun camera PN AN/N-6A and states that it uses 16mm 100 foot Plus X film packs. However, nowhere in any of the manuals is the FSN called out for the film; consequently, it cannot be ordered through channels. Do you have any idea what the correct FSN number is?

CPT J. D. L.

Danny's answer: There are three films available by FSN. They are Slow—FSN 9G 6750-577-4901, Fast—FSN 9G 6750-597-1545, and Color—FSN 9G 6750-973-3705.

Dear Danny: If the procedure given in the dash 10 for using the air conditioner while on the ground (paragraph 10-69) is used in the OV-1C, it causes the oil temperature to exceed the red line and could damage the engine. How about this?

CW3 N. D. P.

Danny's answer: You must be operating your Hawk in the desert or where it's extremely hot. Tests conducted by the U. S. Army Aviation Test Board have shown that the operating conditions contained in paragraph 10-69 of TM 55-1510-204-10/4 and TM 55-1510-204-10/5 are not compatible with the maximum efficiency of the engine oil cooling system when operating at ambient temperatures of 95 degrees F. or higher. The next change to these TMs will carry the following CAUTION following paragraph 10-69.

CAUTION

During ground operation at ambient temperatures above 35 degrees C. (95 degrees F.), operating an engine at high power settings with the propeller feathered may cause oil temperature limits to be exceeded. Oil temperature should be monitored closely when operating under these conditions.

Dear Danny: In the December issue you made the statement that there was no way for a Mohawk pilot to check if the detonator squib had been installed in the Aero 15 rack. I disagree. The squib can be checked by opening the back cover that's held with a Dzus fastener. A problem that we do have is that the detonator squib is not listed in any of our maintenance or parts manuals. How can they be procured?

CPT W. D. L.

Danny's answer: I tried to find an easy way out on this one but couldn't. I just have to take my lashes and cover my head and admit I goofed. I didn't have an Aero 15 rack to look at when the original question came in so I went to the aircraft manufacturer for an answer. Their procedure calls for an ordnance man installing the detonator squib during preflight and removing it during postflight. The pilot is not involved with the squib in any manner. Based on this procedure they answered my inquiry and I passed it on without further checking. Need-

less to say, I learned my lesson. Checking into the matter personally I find that the installation of the Squib can be checked by removing the cover of the Emergency Jettison Assembly. The FSN for the detonator is 1377-793-9926 and will appear in the next change to the 35P manual for OV-1 aircraft.

Dear Danny: While in flight school I was taught to fly the U-6A using 1850 rpm and 28 inches Hg for cruise. I cannot find this power setting in the new U-6A manual. What is the correct power setting for cruise?

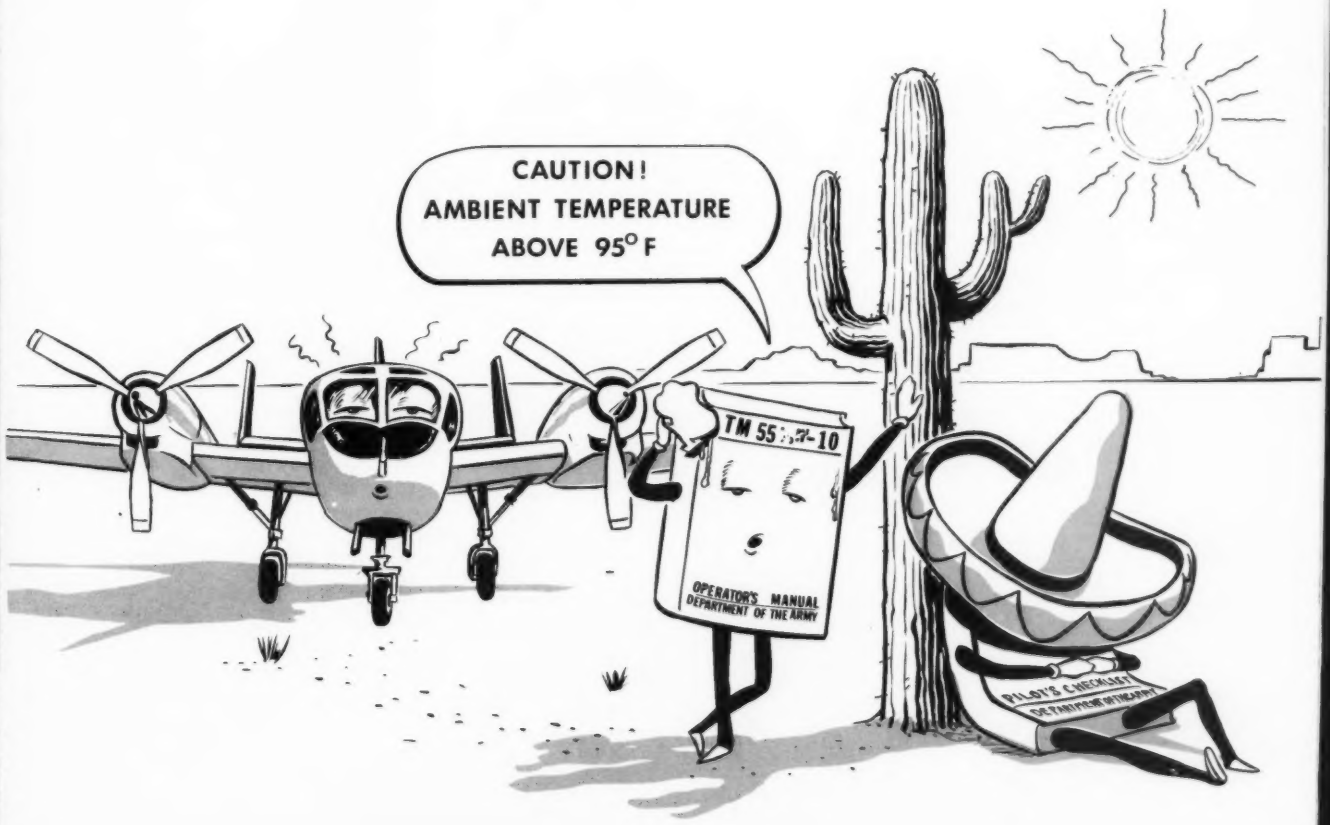
CWO C. J. D.

Danny's answer: When USAAVNS used the U-6A for instrument training, the 1850/28 power setting was utilized as a compromise to make it easier for students (and instructors). The recommended power settings for best performance at the altitudes normally flown in U-6A aircraft are shown in the engine power schedule charts located in chapter 14 of the dash 10.

Dear Danny: We have a discussion going in our unit on instrument flying of the CH-54. What is the straight poop?

CW3 H. B. D.

Danny's answer: You hit on a point which plays on semantics, and a delicate area. The CH-54 is a commercial "off the shelf" procurement which was certified by FAA for VFR operations. Although it has not been certified by FAA or approved by a military test unit for IFR operations, it is equipped with the proper navigation and avionic equipment for instrument flight as prescribed by AR 95-1. However, it is not capable of instrument flight, because in the manual the word capable means "having been approved by an authorized agency for instrument flight," which is either the FAA or the Military Test Unit at Edwards AFB, Calif. Both TM 55-1520-217-10/1 and dash 10/2 are being corrected which will attempt to clarify this situation. It will advise that the aircraft is not certified for instrument flights and "under normal circumstances, the pilot will not take off or fly into known IFR conditions unless dictated by the urgency of the situation." I hope this explanation helps to settle the discussion.



ANNUAL
AWARD
Monthly Winner
CONTEST

Radar contact! Your worries are over, after all, now you're on the "big eye." What could be easier than that? Clouds dance magically all around the aircraft. You feel secure, comfortable— a serious mistake. You are about to become a victim of . . .

IFR APATHY

Lieutenant Colonel Donald R. Jordan

"ARMY 12345, this is Felker Tower, I have your clearance, over."

"Felker Tower, this is Army 12345 ready to copy, over."

"Army 12345 to the Roanoke airport via direct Hopewell VOR, flight plan route, maintain 6,000, contact Norfolk Approach Control, frequency 319.4 when airborne, read back."

"Roger," and the pilot reads back correctly.

"Readback is correct, call when ready for takeoff."

"Felker Tower, Army 12345 ready for departure, over."

"Roger, Army 12345 cleared for takeoff, maintain runway heading, over."

"Wilco."

And we're off like a herd of turtles.

"Norfolk Approach Control, this is Army 12345, over."

"Army 12345, this is Norfolk Approach Control, radar contact." With those words—radar contact—the pilot's worries are over because he knows he's on the big eye. Seems simple since all position reports are eliminated. But, maybe it's too simple.

Let's pick up old 12345 after about an hour. Our friend I. M. Apathy, pilot extraordinaire, has been doing an excellent job of flying through the overcast skies of Virginia. His trustworthy copilot "Speedy," meanwhile, has been listening to selections from the "Woodstock" album on the radio, between frequent catnaps brought on by the confidence he has in the FAA man on radar.

"Army 12345, this is Washington Center, over." (They had been switched to Washington Center some time prior.)

When there was no response

on the radio, Washington Center called again.

"Hey Speedy, Washington is calling."

"Huh, oh yeah, Washington Center, Army 12345, over."

"Army 12345, Washington Center, radar contact lost, report Rockfish Intersection, over."

Where are the charts? Where the heck did that E6B navigation computer go? Where are we? What do I do now coach?

The plague of radar environment—"IFR apathy"—has struck again. If this flight had been well planned there would have been a defensive barrier set up to ward off this menace. The old adage, "An ounce of prevention is worth a pound of cure," is most appropriate here. The prevention has already been prescribed for all Army aviators. It merely requires that the aviator make use of it. The formula is equal parts of:

- Review of publications such as TM 1-225 and AR 95 series.
- Preliminary weather/NOTAM checking for planning data.
- Plan proposed flight on appropriate charts.
- Study of instrument approach procedures for primary point of landing and possible alternates.
- Review of appropriate data in VFR and IFR supplements of FLIP.
- Study of Section II, Planning Data and Procedures.
- Preparation of DD 175, Military Flight Plan.
- Preparation of Instrument Flight Log (DA Form 2283).
- Final weather briefing and recording.

Mix the above thoroughly with lots of preparedness, common sense and alertness, then apply liberally.

The latter step is very important since it does little good to forget everything once on radar contact. When on an interstate highway you certainly don't become oblivious to your surroundings. You are aware of the locations of gas stations, restaurants, rest areas, towns, etc. The same should hold true in the air. Use the sign posts of the airways such as intersections (compulsory and noncompulsory reporting types), intersecting airways and radio station passages.

Let's see how this flight should have been planned. The first step should have been to review such items as TM 1-225. Each year there is an exercise called the annual writ, and many aviators bone up on use of the navigational computer from this TM. Once the exam is over, however, they seem to forget both it and its valuable data.

I recently read in the AVIATION DIGEST under "Potpourri" the following: "Overheard in operations the other day . . . 'I'm returning to Camp Faraway this moring in a U-6 (IFR), can you tell me how the transponder works?'" O.K., sounds innocent enough, but where would you direct someone for the information if asked?

TM 1-225, chapter 16, has indepth information on how both the ground and airborne radar components and systems function. In case you are lucky enough to have an airborne weather avoidance radar, check chapter 16 for some good poop on that system too.

How do you perform VOR checks to see if equipment is within limits, to include check of dual VOR receivers? Take a look at chapter 10 of TM 1-225. Often the question arises, Can I use a teardrop procedure turn although it is not published? Check TM 1-225 and you will find that the answer is "yes" and even be told how to execute it. There's lots of good, need-to-know information in the TM.

Now, what about the AR 95 series? When are you required to list an alternate on your 175 for an IFR flight plan? Can you file a composite IFR/VFR flight plan? What minimums must be forecast before you can request an IFR clearance? Did you know that if you are an instrument rated pilot in command of an aircraft instrumented for an IFR flight in CONUS you *must* file an IFR flight plan unless certain conditions of time and weather cannot be met? What is an operational hazard report and what information must it include? What equipment must be aboard and operative to perform IFR flights? All this data and more is in the AR 95 series.

Why a preliminary weather/NOTAM check? This step should need no explanation, but you might be surprised by the number of pilots who enter operations and make a beeline for the blank 175s without making a weather check.

As an instrument examiner I often make this point the hard way. I'll tell an aviator to prepare a flight plan for a particular destination and if he starts right in on a 175 I slip away and call the weather forecaster. Explaining the situation, I ask him to come up with some off-the-wall forecast which places the proposed destination below minimums. After about a half hour of intensive work, the candidate finally gets to the weather forecaster. All that work for naught. Sneaky? Maybe so, but it sure brings the point home. Also, how can you compute estimated time enroute (ETE), fuel reserve, etc., if you don't have planning data like winds and temperature?

How about planning the flight on appropriate charts? Let's say

you are making a flight from Savannah, Ga., to Miami, Fla.—a fairly simple maneuver. You can see from FLIP that Chart L-19 and Airway V-3 will get you there. So put yourself in a plane and bore on down to Miami.

Upon arrival, approach control asks where you are going to land and you advise them Miami International. You are told to report over the Biscayne Bay VOR. Upon station passage you dutifully call and report the VOR. Then you are cleared for a 27R, back course ILS approach to report Flagler Intersection. Now where the heck is Flagler Intersection? It sure isn't on Chart L-19.

There are two places to get this data if you are on the ball. One source is the FLIP area charts (A1-A2), panel C of A1 to be exact. This expanded view of the Miami area shows Flagler Intersection as the final approach fix on the 27R back course ILS. The second source is the approach plate itself. Again, simple enough but watch the mad scramble that sometimes occurs in a cockpit. Believe me, IFR in a high density terminal area like Miami is no place to start scrambling for charts—do that before you file!

What about studying approach procedures before the flight? The annual writ last year is a good example of this need. Certain type approaches are normally expected to have lower minimums than other types. This myth was exploded by the writ and this point alone contributed much to the high miss rate on approach minimums questions on Version IV of the exam (see the September 1970 AVIATION DIGEST). For example, a straight-in back course ILS or localizer approach to runway 17 at Memphis has lower approach minimums than the front course ILS without glide slope (640-¾ as compared to 780/40). In fact, even the circling minima for Category A aircraft is 40 feet lower. Study of the approach plates beforehand could mean successful mission accomplishment.

How do you fill out a DD Form 175? If you are on a stopover flight plan, where do you list all stops between departure and final destination? Under the passenger/cargo code block, of course! (See paragraph IB 3 of section II of FLIP.) There are other items which are vital to a well prepared flight plan in section II of FLIP. Why not use it and save having to be corrected by the operations clerk when you file the flight plan.

Instrument Flight Log (DA Form 2283) is not required by the ARs but is provided for your convenience. It is a planning guide and, upon completion, provides a centralized collection of inflight data, both published and computed. Station frequencies, identifiers, leg distances, cross-check bearings for intersections, etc., can be transcribed from charts for ready reference while ETE and ETA can be computed and recorded based on forecast conditions. These can be recomputed and entered based on actual conditions as encountered, but all the necessary E6B information is readily available from the card.

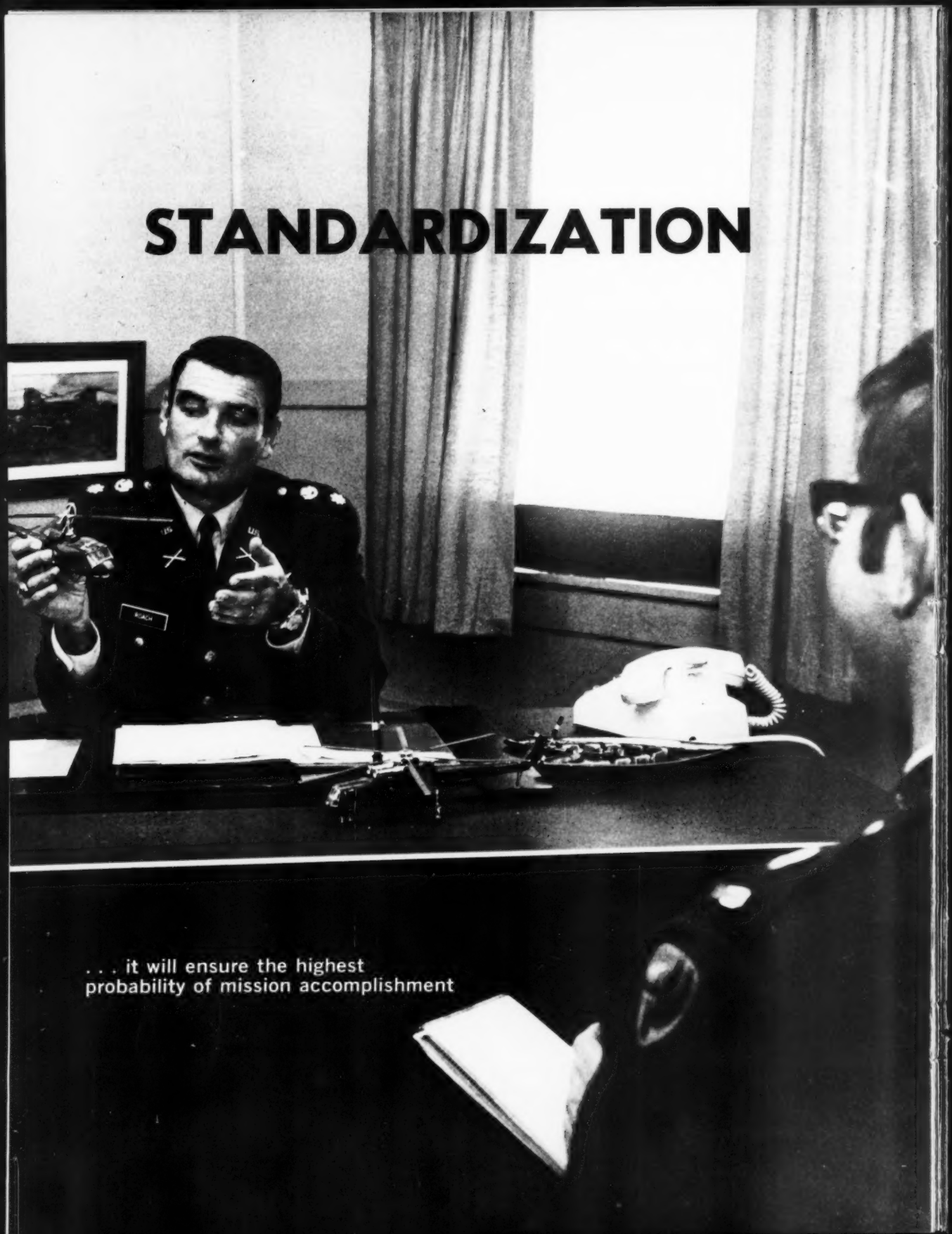
To accommodate each aviator, techniques differ in using the logs. One method is to record all possible reporting points (compulsory and noncompulsory) on the log and then underline the compulsory reporting point. That way any possible requirement ATC wants is readily available. The main point is that some pattern be used so that planning is thorough and complete.

The final weather briefing and its recording are self explanatory. However, be alert to ensure that the final weather does correspond with planning data obtained earlier. Many pilots will call from their duty office and get planning data, but by the time they file it may be several hours old.

There are several other areas listed in AR 95-2 under "Action Prior to Flight." These can be considered in the steps already outlined such as computing fuel requirements. Others can be considered in the common sense category. This includes consideration of pilot physical and physiological limitations; don't exceed your limitations. Speedy might have been too sleepy from the night before to be sharp enough for a good IFR flight.

One point listed in AR 95-2 which many, many pilots fail to adequately plan for comes under "Alternate course of action if the flight cannot be conducted as planned." Planning for an alternate airport is not all there is to it. Consider my flight one night when the generator and battery failed while I was IFR. No radios for navigation and no way of determining our location. Then we ran out of the soup into a clear, dark night. The VFR aeronautical charts we carried covered our area of flight, so we were able to identify our position and arrive at our point of intended landing.

Lucky? In a sense yes, but proper planning was the real key to success. The definition of a professional includes the fact that he has great skill in his chosen field. This skill can only be developed through knowledge and practice. Army aviators with an instrument rating have the knowledge. All they need to do is use it— and help stamp out IFR apathy.


STANDARDIZATION
. . . it will ensure the highest
probability of mission accomplishment

During the latter part of January representatives of the Department of the Army, Continental Army Command and the U. S. Army Aviation School met to chart a new path toward a significant milestone in the growth of the Army's aviation program; namely, the establishment of a worldwide Army aviation standardization program. It will affect the working conditions of the thousands of aviators and other crew members assigned to Army aviation activities throughout the world.

The program will put Army aviation into the business of more closely supervising Army aviation standards for all its aircraft and aviation personnel. We've asked Lieutenant Colonel Dick E. Roach, Chief, Standards Division, Department of Standards and Instructor Training at the U. S. Army Aviation School, Ft. Rucker, Ala., to discuss what this all means and how it will affect those flying for the Army

Digest: Colonel, how will the new standardization program affect aviation training bases and aviation units?

Colonel Roach: All air crewmen in aviation units and activities, from the smallest to largest, will be covered by this new program—anything that's considered U. S. Army aviation resources. It will be one of the most comprehensive aviation programs in existence and, in all likelihood, the most significant aviation growth measure of the post-Vietnam era. Its coverage and effect can be compared to the Army aviation safety program. It is significant though that unlike safety, which is fundamentally concerned with conservation, the aviation standardization program is basically oriented on the aviation commander's vital responsibility to employ his resources in the best possible manner. Through this program he would not only enhance his mission performance, but also his achievements in safety, cost effectiveness and the like.

Digest: Even the small aviation detachments with one or two aircraft?

Colonel Roach: Yes, those which have no more than a handful of personnel and aircraft are usually the ones with the greatest need for the type of services which will be provided by the standardization program.

Digest: What kind of aviation standards will the new program prescribe to assist air crews?

Colonel Roach: First, we must do a little catching up. As a result of recent combat experience with airmobile concepts, Army aviation has identified the aerial maneuvers, techniques and procedures needed to conduct airmobile business. And yet, many of the standards which currently prescribe these flight requirements have proven to be fallible. So, a prime objective of the aviation standardization program will be to set standards which will produce the best procedures and employment techniques possible. This will ensure the highest probability of mission accomplishment under the varying conditions of employment and, at the same time, provide factors of safety, cost economy and a proper margin for air crew error. It has already been pointed out, we're trying to repeal Murphy's Law.

Digest: How about the standardization checks necessary for ensuring adherence?

Colonel Roach: Of course, that will be one of the strongest portions of the program; to see to it not only that the standards are properly established, but also that they are applied in such a way that they become the goal of every air crew member.

Digest: It seems that the first job under the new standardization program would be to set the standards that aviation personnel will be expected to observe. Is that right?

Colonel Roach: Yes, there is a major organizational task, too, to get the whole program moving. But, after the system dynamics are developed and the organization established in the field, the review and setting of aviation standards is the biggest comprehensive thing to be done on a continuing basis.

We're planning to do this by setting priorities. First, we're going to take into consideration airmobile employment concepts and the current aviation resources existing to support them. Then, of course, we must begin to influence the military and industrial standard-setting processes which have now become so deeply embedded outside of the aviation program that we have little or no control over them. Then, we'll go from there.

Digest: How long will this standard setting operation take to complete?

Colonel Roach: It may take several years. Of course, there will be short term gains realized almost immediately—and this is good because the need for standardized procedures and techniques is a continuous thing which cannot afford to wait for a

I would never presume to speak for the safety experts

program to become firmly established.

Digest: Will this evolve into a separate agency within the aviation program with several hundred standardizers traveling around the world looking into standardization matters?

Colonel Roach: It's hard to say what will evolve to cover the period . . . let's say . . . 10 years from now. However, it's envisioned that the organization being established must be sufficiently broad in scope to tie the aviation operators to the expertise on a continuing basis. The Army Aviation School with its tenant activities probably is the best repository for operator expertise and should, therefore, continue to be the prime activity charged with safeguarding aviation standards. The school would set flight standards and aviation training policy with regard to air crew performance standards and, then, tie this into a field organization of trained aviation standardization advisors or consultants . . . people that commanders could use to advise them about what kind of standardization program they should set up . . . programs such as unit level instructor pilot selection and training programs and other activities to perform on-site inspections of unit standardization efforts.

Digest: Colonel, how will this program be related to aviation accident prevention?

Colonel Roach: Well, I would never presume to speak for the Army's aviation safety experts . . . they've done an outstanding job conserving combat resources. But, when you look at today's combination of *new* people, *new* technology and *new* concepts in airmobility, you must realize that aviation safety faces a challenge. So, this new aviation standardization program should greatly facilitate the accident prevention program by making sure that flight procedures and techniques don't go into effect until they're established to the best standards possible and in this way we can hope to turn the accident trend downward the way it needs to be done. Of course, if we can do that for the aviation program, we'll have made a notable gain for the aviation personnel of the Army.

Digest: It appears that under this new program a crucial element will be the selection and training of potential instructor pilots . . . conceivably trained within the training base and graduated under the recommendation of highly trained standardization instructor pilots. Aviators worldwide will certainly know whether or not the selection of these standardization instructor pilots is from among the best qualified. If they are not, there would be a feeling that perhaps the program is really not being taken seriously. Has this been taken into consideration?

Colonel Roach: Yes, I think that the important thing about this standardization instructor pilot . . . advisor or consultant selection business . . . is to get some real consumate professionals . . . people that know how to get the best performance from a technical standpoint, not only out of the aircraft but also from the aviators who operate them.

Digest: Then the program will be looking for aviators who are highly qualified . . . specialized . . . in the cockpit?

Colonel Roach: Indeed, it will. And, it will also be looking at the staff aspect of these things, too, because the standardization aviator is going to have to make what amounts to solid staff recommendations. To further elaborate, he will be needed to function also as an advisor, primarily to the aviation commander who necessarily relies on his aviation resources to be properly maintained to mission readiness standards. Of course, there must be a certain amount of training before even the most experienced aviator can go into the field and function as staff advisor and check pilot wrapped into one. To this end a standardization instructor pilot course is being developed and will be implemented as soon as resources will permit.

Digest: Will some standards be put into effect soon?

Colonel Roach: Yes, almost immediately. The worldwide

. . . we must begin to influence the military and industrial standard setting processes . . .

program may not go into effect for several months; however, the embryonic Aviation School standardization program activated last August and expanded under a recent school reorganization has already made inroads into the business of resolving flight standardization problems. Many aviation publications such as operator's manuals and checklists, as well as Aviation School aircraft standardization and flight training guides for particular aircraft, are constantly under review for improperly established standards. However, the latter publications seldom find their way to the field.

Of course, shortly after the program goes into effect, it's reasonable to expect that many of the school's training publications will be converted to or be incorporated within DA level publications to ensure Army-wide dissemination.

Digest: Colonel, one final question. It's been said that aviation standardization programs have been tried several times before, only to fail. What will determine the success of the new program?

Colonel Roach: Historically it's true that there have been some unsuccessful attempts to establish this type of a program. But, most of these were pseudo programs put together like topsy . . . with standardization only to a point and without clear overall objectives. The problem today, unfortunately, is not with those that failed, but with the successful programs which have fragmented standard-setting responsibilities. What we now have adds up to a series of subprograms without real coordination or any relationship between them.

These programs must be decategorized and placed together so that they can be worked out in a way that will meet the entire aviation program's needs. Of course, no program, no matter how well developed, organized, staffed and administered, could ever hope to succeed without comprehensive command support and the individual air crewman's total commitment to standards of excellence.

Digest: Thank you, colonel.

INSTRUMENT CORNER

Q. When cleared for an approach at a facility that depicts a tear-drop procedure turn on the approach procedure and a course reversal is required, does the pilot have the option to deviate from the tear-drop procedure turn?

A. No, when a tear-drop procedure turn is depicted and a course reversal is required this type turn must be executed. Reference: AC 90-1A, paragraph 3g(2) (g)2b.

Q. May descent out of procedure turn altitude be commenced prior to the aircraft being established on the inbound course?

A. No, the altitude prescribed for the procedure turn is a *minimum* altitude until the aircraft is established on the inbound course. Reference: AC 90-1A, paragraph 3g(2) (g).

Q. When an estimate to an enroute fix is more than 3 minutes in error, is the pilot required to revise his estimate if he is under radar contact?

A. Yes, a corrected estimate will be reported at any time it becomes apparent that an estimate as previously submitted is in error in excess of 3 minutes. This is required whether in radar contact or not. Reference: FLIP, section II, page 67, paragraph III,I,3a(6).

Aeromedic

Weight And Balance

Obesity was considered a serious military offense in the Roman Army. A fat Roman horseman was made to give up his mount and become a foot soldier. A similar tradition prevails in Army aviation today. A plump pilot or other chubby crewman can forfeit his flying status as well as his life

Major Nicholas E. Barreca, M. D.

Provided by the Society of U. S. Army Flight Surgeons

To the air crewman: Down through the ages, military services have traditionally frowned upon stout soldiers. During the height of the Roman Empire, obesity was considered a military offense. Rotund Roman horsemen were made to forfeit their mounts and become foot soldiers. A similar tradition persists in Army aviation today. Plump pilots and other chubby crewmen face forfeiting their flying status, perhaps even their lives.

Many senior and master Army air crewmen (the old boys) recall with a decided chill Lieutenant Colonel Rollie Harrison, Army aviation's legendary flight surgeon, shouting sourly across the parade field, "You're grounded, fatstuff!"

Frequently air crewmen question the concern about weight. Many feel that this is a form of harassment—another indignity foisted upon them by the establishment. This is far from the truth. There are many health sustaining reasons for urging adherence to a *lean and mean* stature and composure.

The medical standards for flying are concerned primarily with absence from disease, infirmity, overweight and obesity. They do not require a specific level of fitness, nor can they practically or inexpensively measure for its presence. So we settle for the absence of serious disease or incapacity, and the absence of obesity and overweight.

Obesity is a physician's clinical estimate of excessive fatty tissue or an excessively large fat/lean ratio. Life-long excessive fat has been shown by insurance company studies to be associated with premature death and excessive morbidity from many degenerative diseases. Freedom from obesity is required of air crewmen for this characteristic is felt to be a reflection of fitness and future freedom from certain degenerative diseases.

An indirect measure of obesity is overweight. For a given height and age, overweight usually implies obesity and thus lack of fitness and increased risk or susceptability to the degenerative diseases. Occasionally one finds a tall individual overweight, who is not truly obese, but this is not true as often as many air crewmen would like to think.

The goal is a healthful disposition of the body, a state of fitness in which an individual has a low risk for disease and a high level of physical and mental stamina. Each will likely result in high productivity, alertness and morale—plus longevity.

Many factors contribute to degenerative disease. Recent population studies reveal that proper diet and physical fitness

are extremely important factors. Certainly there are others, such as genetic or hereditary disposition, smoking, personality traits and other environmental influences, but only a few of these can be directly controlled by the individual. Proper diet (minimizing obesity) and physical fitness are controllable (likewise smoking which is extremely important).

As a result of nationally sustained poor dietary habits (overnutrition is a form of malnutrition) and computer age "sitting" existence, *many of you are on your way to premature disability and death.* This is a personal problem. This is your life, not just a statistic in the military machine. You should have a personal interest in undertaking an attainable life-long program of healthful living, not just because the medical standards or your flight surgeon say so, but for your own good.

As Army air crewmen you may say, "So who cares! I'll probably live to my 20 year retirement, even if fat and flabby." This itself is a rather limited and narrow long-range viewpoint. It completely overlooks the immediate benefits of fitness. First, reflect on a concept that evolved from that "cruel and crude" brown shoe army . . . *we are soldiers,* supposedly America's fighting men, not her fat and floppy men. . . . We are not supposed to just exist . . . we are supposed to outthink, outperform, outmaneuver and outclass America's adversaries on all counts. Today, this is a less than popular concept for too many frequently feel that the sophisticated, computerized machine with integrated circuits and night-seeing eyes will solve all of our problems. Time and time again, it has been demonstrated that the machine is only as good as the man behind it. He makes the difference. Obese air crewmen operating their machines within the confines of a variety of hazards, stresses and design limitations are not up to it.

Degenerative diseases are not the only risks linked to obesity. There also are hypertension, diabetes and coronary heart disease with attendant complications. These are not just the diseases of the elderly for in our generation their significant incidence has crept into the ranks of the 20 and 30 year olds. Thus, obesity predisposes the premature onset of these diseases as well as their actual occurrence in general. Other diseases also have been indirectly implicated . . . stroke, arthritis and kidney disease. There is even a higher suicide rate among the obese. Perhaps a look in the mirror at one's bulging reflection on a particularly dourful and bleak morning is all that one can take.

There also are the restraints and limitations of aircraft design to consider. Every extra pound of weight you carry cuts the payload an aircraft can carry. Your unnecessary flab displaces useful payloads of armament, munitions, troops or supplies essential to wage the conflict. At present, aircraft weight and balance tables are designed to consider air crewmen 200 pounds or less. Certainly people are getting bigger statistically, so perhaps a more reasonable limit needs to

be established. For aircraft of the future, the limit will be 240 pounds, yet no present operational aircraft has been designed to this limit. Even when they are, it should not be an excuse to encourage portly crewmen. The added weight can be used as a safety factor as well as for additional payload.

Another aviation requirement for the lean and light air crewmen derives from the design necessity for compatibility with the G-loading of aircraft retention systems. In operational aircraft the design limitation is 200 pounds for each crew member. Present criteria for G-loading have been upgraded, but no aircraft currently operational has met this standard. It should be understood that a safety factor of 1.5 is multiplied to the above weight, thus increasing the actual G-loading limit on the seat and restraint system to 300 and 380 pounds respectively. This might at first seem to negate the effect of a crewman's overweight on the restraint system, but one also must consider that the safety factor is provided to account for crewmen's equipment (e.g.—uniform, boots, helmet, gloves, body armor, knee boards, survival equipment, flak or web jackets, individual weapons and miscellaneous personal items). Thus, the higher the crewman's weight the more closely he approaches—and potentially exceeds—the G-loading of the system even with a safety factor. Thus, he minimizes his survivability when sustaining crash G-force decelerations.

Finally, there are the risks of obesity associated with the aviation stresses themselves. The altitude stresses, particularly decompression sickness, are more poorly tolerated by the obese. Low magnitude, sustained G-forces also are more poorly tolerated, as well as abrupt high magnitude crash forces as explained above. And, heat stress is more poorly tolerated by the obese air crewman. Generally the obese individual is more prone to skill fatigue. Finally, he has more difficulty conforming to equipment. Aircraft and supporting equipment just are not designed for fat people. It's difficult enough to get into one's crew position with all required paraphernalia without having to contend with bulging bottoms, plump pouches, stout shoulders and thick thighs.

Then there are the risks of inactivity and poor physical fitness. These factors share a vicious cycle with obesity. In fact, they are almost inseparable. Statistically, decreased fitness and/or activity are associated with an increased incidence of many forms of cardiovascular disease. Often it has been demonstrated to decrease one's tolerance to the aviation stresses. Physical fitness has even recently been used as a form of therapy to prevent or reduce the effects of certain cardiovascular diseases. As with other forms of therapy, it must be prescribed under a physician's supervision.

Physiologically the benefits of physical fitness and weight control include an increase in the heart and lung reserve with attendant decreased resting pulse rate, decreased maximum heart rate, increased heart output, increased vascularity of the heart and other muscles, increased recovery of the pulse after exercise and increased lung vital capacity. There also are changes in sugar and fat metabolism which might be protective in the face of predisposition toward diabetes and vascular disease. In certain cases physical exercise has been used to lower blood pressure in mild and early hypertension.

Table of acceptable weight (in pounds) as related to age and height for Army aviation

	MINIMUM	MAXIMUM				
Height (inches)	(regardless) of age)	16-20 yrs	21-24 yrs	26-30 yrs	31-35 yrs	36-40 yrs	41 years and over
60	100	137	143	146	148	151	152
61	102	142	148	151	153	155	156
62	103	147	153	156	158	160	161
63	104	151	157	160	162	164	165
64	105	156	162	165	167	169	170
65	106	160	166	169	171	173	174
66	107	165	171	173	175	177	178
67	111	169	175	178	180	182	183
68	115	173	179	182	184	186	187
69	119	177	183	185	187	189	190
70	123	180	186	189	191	193	194
71	127	184	190	193	195	197	198
72	131	187	193	196	198	200	201
73	135	190	196	199	201	203	204
74	139	193	199	202	204	206	207
75	143	196	202	205	207	209	210
76	147	198	204	207	209	211	212

More tangible benefits of physical fitness have been achieved in industrial environments. There has been a decrease in absenteeism and sickpay, a decreased rate of accidents and an increase in work capacity and productivity. People simply perform better, are mentally alert and have higher levels of morale.

Not to be underestimated are the individual psychic benefits enjoyed by the person successfully participating in a weight control and physical fitness program. This often pertains to one's vanity . . . an increased self-esteem and an increased appeal to the opposite sex.

Despite the fact that undernutrition has been found to be a recent problem in certain segments of the American population, it is unlikely in the Army aviation population. *However, air crewmen are frequently malnourished due to overnutrition.* Frequently, we remember the admonitions of our grammar school teachers for the balanced American diet. This included a three course breakfast that would gorge a dock worker. Meals must be balanced with the proper proportions of protein, carbohydrate and fat, but the calorie content must be consistent with sedentary energy requirements. Flying airplanes requires little physical energy.

Another dietary problem arises from our parent's good intentioned, but oft damaging desire to have us finish our meals. The warning to "take what you want, but eat all you take" . . . or "finish everything on your plate" . . . or "eat it, it's good for you" rings in all our ears. Many of us just never learned how to stop stuffing ourselves. As a result we may be predisposed to having more difficulty in controlling our weight. Just because baby is round, plump and red-faced doesn't mean he will be healthy. Often these children are doomed to lives of obesity. What is needed are more lean and hungry looking children on balanced diets consistent with their needs, not those of their parents. So much for the lineage of bad eating habits. Here's some recommendations:

- Decide on a program that combines weight reduction with a gradually increasing program of physical fitness. Combine this with no smoking and you will have removed most of your suicidal tendencies.
- Adhere to the program for the rest of your life. Persons who are obese will never be able to go back to old eating habits and expect to remain slim. You must undertake a life-long program of diet consciousness. Realize at the start that this will not be easy.
- See your flight surgeon and have him assist you in choosing the appropriate diet for your age and level of activity. According to the National Research Council, the average American male indulging in his usual sedentary existence, requires no more than 2,800 calories a day at 22 years of age. From 35 to 55 years this requirement is reduced to 2,600 calories, and 2,400 calories for more senior citizens.
- Once on this diet realize that to lose weight one must eat fewer calories than the body needs. No matter how little you eat, it's too much if you do not lose weight.
- Avoid all fad diets like the plague. No one can sustain themselves on these diets for life. Intermittent fad diets, with sudden losses of weight followed shortly by regain, are probably harmful.
- Drugs have no place in a weight control program. Their effects are short-lived and they are attendant by side effects and complications which far outweigh their usefulness.
- Attempt to eat three meals per day, avoiding snacks. Air crewmen should certainly eat breakfast for often the occasion for missing lunch arises. Remember it will usually be more than 12 hours until supper. Even the stoutest becomes a little hypoglycemic (decrease of sugar in the blood) after half a day. Missing breakfast and lunch is usually followed by an indulgent supper followed by little or no activity.
- Avoid candy, cake, carbonated beverages, preserves, alcohol and all other heavy sources of pure carbohydrates (sugars). These are fine for arctic survival.
- Keep an eye on Army medical standards for maximum weights in flying personnel (see table). These standards were revised and made more stringent on 10 November 1969. Most importantly, remember that at each age and height category, the maximum allowable is listed, *not* the ideal. Insurance company ideal weights are approximately 10 percent lower than these maximum figures.
- Once you have met the medical fitness standards for weight, one further test is required. Look at your belt line. Is something hanging over it? If so, you are still obese. Pick up a fold of flesh from this area; if you have more than three-eighths of an inch, you can safely lose more weight.

That takes care of the dietary recommendations. Now what do you do for exercise?

- Adopt a program of aerobic exercise for life. Such a program is presented in great detail in AFP 50-56, entitled GMT-USAF Aerobics Physical Fitness Program (Male). This is one of the few exercise programs with medical and physiological research to support its claims.
- The most convenient although most boring exercise is running. It can be done most any place. However, community or group running

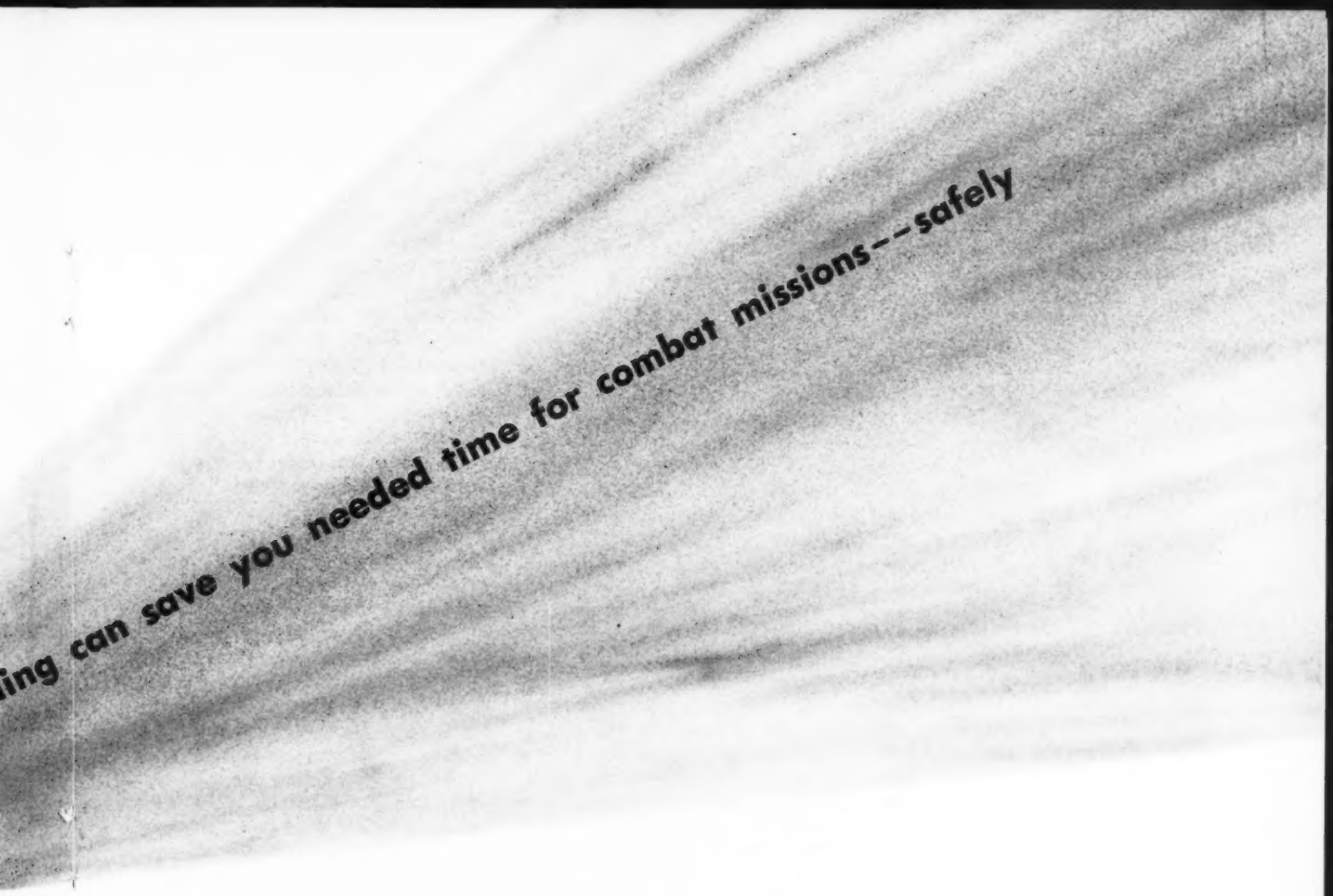
Continued on page 35

Rapid Refueling The CH-47

CW2 Marvin T. Hesket

RAPID REFUELING of Army aircraft in the Republic of Vietnam (RVN) is a necessary, safe and an usually efficient procedure. This term applies to refueling helicopters with engines running and blades turning, thus allowing the aircraft to be completely refueled in minimum time.

The CH-47 Chinook, A and B models, must be refueled every 2 flight hours to provide a 20- to 30-minute fuel reserve. This, of course, does not include the added range that internal tanks would provide. A CH-47C model aircraft can be flown about 210 minutes per fuel load. Flying with maximum gross weight will



raise fuel consumption, sometimes cutting the time per fuel load to less than 105 minutes in an A or B model. An 8- to 10-hour day per aircraft is frequent in RVN and 10- to 12-hour days are not uncommon.

It is easy to see that many Chinooks are completely refueled five and six times in one day. If each aircraft had to shut down and start up again each time, there would be approximately 10 to 15 minutes extra required at each refueling. Over a long period the extra mission time saved by rapid refueling is a valuable asset to the mission capability of the assault support helicopter units.

Crew members who fly Chinooks daily in Vietnam refuel the aircraft frequently and many become complacent and disregard basic safety rules. Whenever the aircraft is being refueled, each crew member should have his Nomex sleeves rolled down and fastened, gloves on and helmet visor down. Also, pilots should close their cockpit windows in case of a flash fire. The most dangerous time in a fuel fire is when the fumes in the air, circulated by the turning blades, ignite. Visors protect the eyes from the initial flash and the clothing protects the body long enough for a crew member to exit the fire area before being seriously injured. Unprotected eyes and skin, however, will most certainly be seriously injured by the first fuel flare-up.

The CH-47 has fuel caps that are above the eye level of an average person, thus making it easy to overfill the tank and allow fuel to spray out onto the refueler. JP-4 fuel will chemically burn unprotected skin and eyes, but if the crew member is wearing the proper clothing and his helmet visor is down, he will be protected from eye injury and skin burns. The seconds it takes to put the visor down may some day save your eyesight.

The aircraft commander should ensure that each crew

Rapid Refueling

The CH-47

member is properly briefed *prior* to the flight on the proper procedures and safety measures that must be followed during refueling. He should make sure that each person knows that he must wear his clothing and equipment properly; that the aircraft must be properly grounded *before* the nozzle is inserted into the tank; and that care must be taken not to allow the fuel to overflow onto himself or others.

In RVN the crew chief and gunner should each refuel one side of the aircraft, if more than one fuel hose is available, and the flight engineer or pilot should monitor the refueling with a fire extinguisher in hand.

Never refuel an arcraft with passengers on board. Either plan to refuel without passengers or make them wait at a safe distance.

Whenever an aircraft is to be refueled, it must be grounded to prevent static electricity from igniting the fuel. I have witnessed several inexperienced crew members taking off the fuel cap, putting the nozzle into the tank and then plugging in the ground wire. A spark jumping from the aircraft to the nozzle could cause an explosion before the ground wire does any good. Be sure crew members are briefed to ground the aircraft *prior* to taking off the fuel caps.

Many aircraft have been blown about on a refuel pad by a Chinook hovering too close. Most refuel pads are busy and crowded and many refuel all types of aircraft at the same time. If Chinooks must be refueled near other aircraft, use extreme caution while maneuvering. Ground taxi, if possible.

Often OH-6 pilots must friction lock the controls, get out of the aircraft and refuel their own ship. A Chinook hovering close by, upwind of a small OH-6, could cause the aircraft to turn or lift off without a pilot. Even if the aircraft was not damaged, the turning could cause the fuel nozzle to come out of the aircraft and spill fuel, possibly injuring the person doing the refueling. Even another Chinook can be lifted off the ground by a CH-47's rotorwash.

At least one Chinook sustained major structural damage because another Chinook hovered too close. The aft end of the parked Chinook was lifted by the rotorwash while the ramp lever was in the down position, allowing the ramp to go full down. When the aircraft was slammed back to the ground the ramp hit first, causing the ramp actuators to be driven up into the aircraft structure.

Never hover close to another aircraft unless necessary, especially upwind of the aircraft. When refueling always make sure that the ramp control lever is left in the *stop* position to prevent the ramp from dropping lower in the event your aircraft is raised by someone's rotorwash. Reducing the rpm to minimum beep while refueling will also help prevent the aircraft from being lifted inadvertently.

There is one other rule that is very important but is violated occasionally. Never smoke within 50 feet of any aircraft on the ground or near any refuel area. I have seen passengers light a cigarette near aircraft being refueled. Apparently they do not realize the danger of smoking near aircraft and aviation fuel, but it is your responsibility as a pilot and air crew member to ensure this rule is enforced.

Be alert near the refueling area for hazards to aircraft and other personnel in the area.

Aircraft commanders must use extra caution and vigilance during hot refueling operations in detecting fatigue resulting from extended tactical operations. Rapid refueling is valuable and effective in the tactical area of RVN, but if one aircraft, crew member or passenger is lost because of improper procedures or lack of safety precautions, the value of this refueling method is lost.

Continued from page 31

or a transistor radio frequently makes it tolerable.

- It is best to exercise at a minimum of 4 days per week.
- In order to achieve full benefit one must exercise to achieve a pulse rate above 150 at ages below 55 years and sustain this for approximately 12 minutes per day.
- If you have not reached the age of 30, you can usually start your exercise program with little medical supervision providing you have a current annual flying physical.
- Past 30 seek medical clearance first and start your exercise program slowly.
- Never overstress yourself. Take the advice of a chaplain who is a life-long exerciser, "Train, don't strain!" Expect a few mild strains and aches...sore ankles, knees, shins, calfs...and nurse them along. However, if they persist or are incapacitating, seek the advice of your flight surgeon.

There you have it. What are you going to do about it? Will you wait until your next flying physical examination and the embarrassment and harassment of medical restriction and crash diets? Here's a solution! Repeat to yourself the following words while appraising your birthday suit reflection in the mirror...*fat, flabby, fleshy, floppy, corpulent, stout, rounded, thick, plump, chubby, slovenly, paunchy, slack, flaccid*...had enough? Get to work then!

Think of the benefits. You will achieve a level of health that is compatible with extended longevity, increased productivity, higher morale, a better personal attitude and an increased tolerance to the stresses of the aviation and military environment.

To the flight surgeon: The success of an air crew member's weight control and physical fitness program frequently depends upon the enthusiasm with which flight surgeons pursue and support such efforts. Certainly the flight surgeon must lead by his own spirited example. The success of a military program of diet and fitness depends on the following factors:

- A means of identifying those personnel who are certainly unfit. Generally this is satisfied by identifying overweight personnel. These are the ones needing the most help.
- Initiation and maintenance of a weight reduction program, consisting of medically supervised diet, physical conditioning and motivation.
- Periodic weigh-ins to chart progress and stimulate adherence to the program and the development of sound dietary habits.
- Enlistment of command emphasis to ensure a cooperative attitude on the part of participants.

Flight surgeons must continually remind themselves that weight control programs are not simply to meet an AR requirement. They are not meant to be a form of indiscriminate harassment. They are meant to enhance the health and fitness of the flying population in general. With a comprehensive, well organized program flying duty seldom has to be interrupted. This is not to say that it shouldn't when air crewmen fail to cooperate.

A positive rather than a negative approach must be used. The air crewmen must be given specific guidance about the nature and conduct of a diet. Dietary counseling by a trained dietician or nutritionist is desirable. Often the problem of eating in mess halls precludes adhering to a specific weight reduction diet. Sometimes special provisions can be made along with special dietary instructions and restrictions.

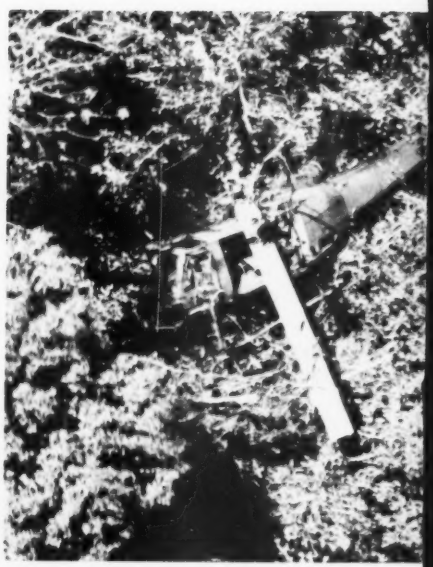
Once provided with adequate dietary instruction, each individual should be instructed in the principles of an aerobic exercise program. Many publications, both popular and professional, have reviewed the nature and limitations of such programs.

Thereafter, the air crewman needs continued guidance and follow-up, just as any patient with an infirmity for which there is a teatment. Often a weekly or semi-monthly visit will ensure continued motivation and lack of discouragement due to slow progress.

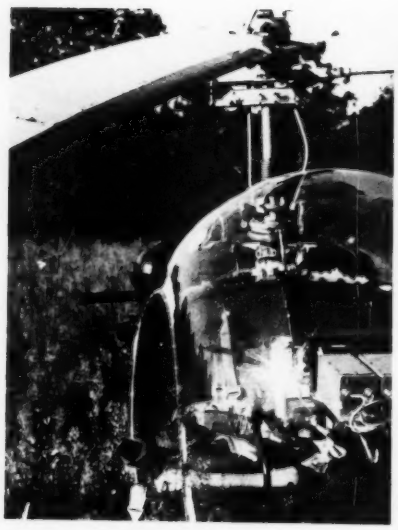
Finally the flight surgeon should engage in frequent presentations of the risks of obesity and unfitness, as well as the benefits and well being accompanying weight control and physical fitness. Such efforts frequently enlist the support of commanders responsible for personnel health and management.

The above normally takes care of those obviously in need of help. But how about the rest of the community...those slithering around in various states of physical unfitness, with insufficient energy or stamina to even do anything about it? They need an example. They need encouragement. They need command emphasis. Frequently they need to be led by the hand to a convenient facility at a convenient time. In the Army one frequently sees organized programs of fitness for recruits, students, the airborne, rangers and special forces. For the rest, the majority, the regulars, there are few organized programs. Thus the flight surgeon has a job to do and it is *preventive medicine*. This is the real thing—saving perhaps a hundred lives at a time from premature disability and death.

Captain Alfred J. Bevilacque
Data Center
USABAAR



Easily prevented, but a continuing problem



FUEL EXHAUSTION

ONE OF THE MOST prominent and least forgiving problems in Army aviation today is fuel exhaustion. During FY 1970, fuel exhaustion resulted in 43 mishaps and cost $2,240,694. Involved were 81 crew members and passengers, 14 of whom sustained serious injuries. Of the 43 mishaps, 36 were directly related to crew error, and five of the remaining seven had crew error as a contributing factor.

This thought comes to mind: "Those guys just got caught in bad weather and exhausted their fuel while desperately looking for a place to land!" If this was your thought, you're in for a surprise. Only two of the 43 mishaps involved any kind of weather as a contributing factor.

Another thought: "Most of them must have been fixed wing pilots who couldn't find a place to land." Wrong again. Of the 43 mishaps, 37 involved helicopters.

"Well, you can't sit a helicopter down just anywhere in Vietnam and wait for help to arrive with fuel while Charlie gives you a case of lead poisoning!" True, but only 22 of the 43 mishaps were in Vietnam and 14 of the 22 pilots involved tried to stretch their remaining fuel to reach POL points rather than sit down at fire support bases or other secured areas.

A recap of a few actual experiences will give you an indication of how serious a problem fuel exhaustion is. A pilot had returned from R & R the previous day and arrived at the flight line at 0900. Briefed on a visual reconnaissance mission he was to fly, he went to his OH-6A. After starting, he saw that he had 300 pounds of fuel registering on the fuel gauge. He took off and flew to the area he was to recon. After 40 minutes, he saw the fuel gauge was registering 150 pounds of fuel. After 45 minutes, it had dropped to 100 pounds.

At this point, the pilot elected to leave and return to his home station. Entering an extended right base to the traffic pattern, he was at 150 feet and approximately 70 knots when the engine lost power, surged and quit. The master caution light came on due to low rpm and the engine-out light came on. The pilot entered autorotation with rotor rpm in the low green. He stated later that during the autorotation he was in a normal descent and had picked out his intended touchdown point. Nearing his intended touchdown point, at approximately 30 feet, he noticed a small knoll and attempted to extend his glide over it by applying pitch. He did not recall what his altitude was when he flared.

The helicopter hit the ground in a high rate of descent and the tail boom hit the knoll and was torn off. Simultaneously, the blades flexed and hit in the vicinity of the engine fairing assembly. The helicopter skidded forward approximately 15 feet, spun 110 degrees left and came to rest. The tail boom, tail rotor and part of the engine fairing were approximately 30 to 40 feet to the rear. The crew escaped injury and there was no postcrash fire. The entire flight lasted 1 hour and 15 minutes.

When he was interviewed, the pilot stated he had failed to visually check the fuel tank. He also stated he did not check the records where the fuel gauge was written up as inaccurate. He said he had a full tank of fuel when he departed because

These photographs illustrate typical fuel exhaustion accidents

another pilot had topped it off the night before and this was the first flight of the day.

The fuel cell covers were removed and only a trace of fuel was found in the cells. There was no fuel in the lines and only a trace in the filter. The OH-6A was carefully examined and no holes were found in the fuel cells or other fuel system components.

Investigation revealed engine failure was due to fuel exhaustion because the pilot did not make a proper preflight and failed to check the logbook which contained an entry about the inaccurate fuel gauge.

Another typical example happened closer to home with no mission urgency, nor any other extenuating circumstances. The helicopter involved was an OH-23B and the pilot was only flying to get flight time. He arrived at the flight activity at 1015, talked briefly with the maintenance personnel and other unit personnel, then filed a flight plan, conducted his preflight and prepared to take off.

He took off at 1110, flew around the local area, then to a nearby airport where he shot a few approaches and landed. After shutting down, he went to the airport restaurant for a sandwich and a cup of coffee. After about 30 minutes ground time, he took off again and flew toward his home base, following a highway. When he was about 3 miles north of the airport, the engine stopped and he entered autorotation. He picked a spot on the highway median and was heading for it when the engine restarted and the needles joined 400 feet above the ground.

Since he was only 2 miles away at that time, he decided to try and fly to his base. Fifteen seconds later, the engine surged and stopped again. Entering autorotation, he began an approach to the highway median. At 100 to 200 feet above the ground, he saw wires in his flight path that he had not noticed before. He used part of his available collective and cyclic to overfly the wires and landed extremely hard on the highway. The helicopter slid a short distance down the highway and came to rest severely damaged.

The accident investigation board found this accident was caused by failure to maintain an adequate fuel supply and by improper control techniques to avoid the wires. His improper control techniques resulted in inadequate pitch control and the crash landing. The board also found this pilot made no effort to monitor his fuel and never realized his critical shortage. Because of this, he did not realize the extent of his emergency or the reason for the first engine failure.

Another typical example involved a fixed wing aircraft flying a routine mission. The pilot had more than 3,000 flying hours and was a well qualified senior aviator with a standard instrument rating.

He took off at 0907 in an OV-1 on a local VFR flight plan, with only the main fuel tank filled. He made two practice ILS approaches and flew on to an omni station at 4,500 feet. After departing the omni at 3,500 feet on a course back to his home airfield, the low fuel warning light came on at 1045. The pilot continued toward his home field omni, contacted approach control and requested an instrument approach clearance. The field was then IFR, with a 500-foot variable broken ceiling and 10 miles visibility.

The pilot didn't tell approach control about his fuel state, nor did he request a straight-in approach. Consequently, he was cleared for a normal ILS approach to runway 08. After he passed the outer marker inbound on final, both engines quit due to fuel exhaustion. The pilot elected to ride the airplane down because he thought he was too low to eject at 200 feet and 120 knots. He crashlanded in a cornfield three-quarters of a mile short of the runway 2 hours and 4 minutes after takeoff and 26 minutes after the fuel warning light came on.

The accident investigation board concluded this accident was caused by fuel exhaustion due to improper flight planning by the pilot who thought he had 2 hours and 45 minutes of fuel with only the main tank full. After the 20-minute low level fuel warning light came on, the pilot did not believe he had only 20 minutes of fuel left. Because of this, he did not notify approach control about his condition and request a straight-in GCA letdown.

These cases are a small sampling of typical fuel exhaustion mishaps. During FY 1970, accidents resulting from fuel exhaustion occurred at a rate of .62 per 100,000 flying hours. Although this rate may appear insignificant, the probability of fatal or serious injuries is high for each occurrence. Analysis of the trend experienced in FY 1970 indicates this type of accident will recur in the same magnitude in FY 1971 unless all pilots take preventive measures.

Do you know the fuel capacities and endurances with varied power settings for the aircraft you fly? Do you *always* physically check your fuel supply before each flight? Do you constantly monitor your fuel status in flight by elapsed time or do you rely entirely on the fuel gauges? Do you plan all flights with an adequate fuel reserve?

UH-1 CRASHWORTHY FUEL SYSTEM

Major Edwin R. Widmer
Aircraft Accident Review and Analysis Department
USABAAR

AFTER SEVERAL years of development, testing and improvement, the UH-1D/H crashworthy fuel system (CWFS) became operational. The first production model UH-1H with the CWFS rolled off the assembly line during the spring of 1970. Since then, 530 production CWFS-equipped UH-1H helicopters have been delivered. Although the difference in appearance between the old and new system is minor, there is a vast difference in the capability of each. While the standard version primarily provides a means for storing fuel aboard the helicopter, the crashworthy fuel system is designed to enhance the safety of occupants and helicopters.

Fuel in the presence of oxygen needs only an ignition source to burn. Conversely, if the oxygen supply is limited and all ignition sources are isolated from it, fuel cannot burn. The new CWFS is designed to contain fuel within the cells and lines, keeping it away from potential ignition sources during and after a crash sequence. To prevent fuel leakage or spillage, engineers have constructed the fuel cells of an extra-high strength material that can resist ruptures, tears and punctures, while providing self-sealing capabilities in the event of bullet strikes, up to and including .50 caliber.

Some fuel lines are designed to flex and bend, rather than break. Some afford the same .50 caliber protection as that of the fuel tanks. Others are engineered to separate at special fittings under prescribed loads. These fittings have spring-loaded self-sealing valves to prevent spillage.

Since we seldom gain something for nothing, we might expect to pay a heavy price for this improvement in safety. However, the penalty is small. Installation of the CWFS in UH-1D/H helicopters increases their weight by 160 pounds, while reducing the fuel capacity 11 gallons. This

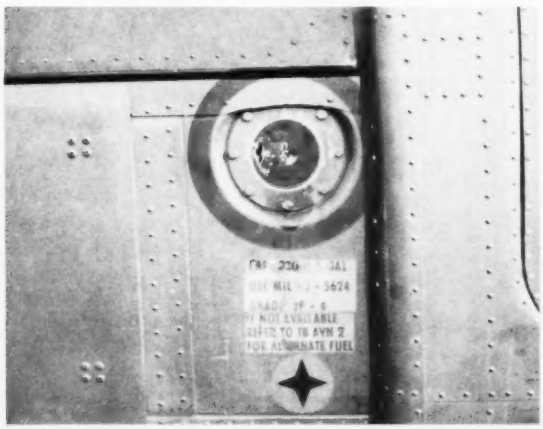
This UH-1, equipped with a crashworthy fuel system, was on approach to an LZ when antitorque control was lost and the helicopter crashed. Despite severity of the crash, there was no fire.

makes the total increase in gross weight of a fully serviced helicopter only 89 pounds. This increase in gross weight, coupled with a decrease in range of approximately 6 or 7 minutes' flying time, is the total penalty—a small price for the safety gained.

In addition to production installation of the CWFS, retrofitting of UH-1D/H helicopters is being accomplished at three overhaul rebuild facilities—the Naval Air Rebuild Facility, Pensacola, Fla.; Bell Helicopter Facility, Amarillo, Tex.; and the Army Aeronautical Depot Maintenance Center, Corpus Christi, Tex. By 30 June 1971, it is estimated that 370 UH-1D/H helicopters will have been converted at these facilities. In all production helicopters, as well as those retrofitted, the fuel warning light is calibrated to give the familiar 20-minute warning.

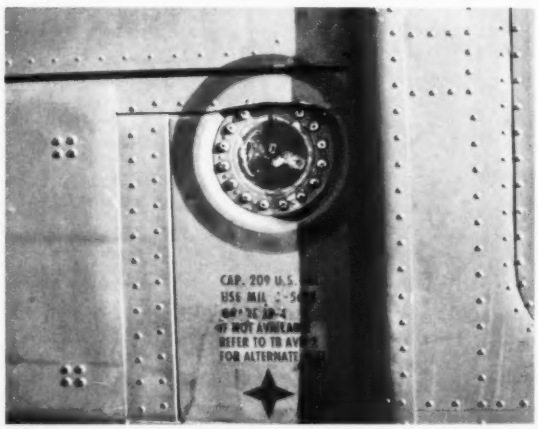
As shown in the accompanying photographs, the most obvious indication of a CWFS-equipped UH-1D/H is the appearance of 14 phillister head screws around the fuel filler receptacle, as opposed to the seven bolts prior to modification. The fuel capacity placard has been changed to read 209 U. S. gallons. Another change is the relocation of the main fuel filter outboard from its previous position, and the aircraft data plate will be stamped CWFS. In addition, a decal is displayed on the instrument panel of retrofit helicopters.

Perhaps the questions foremost in our minds are how well the system will function and how much improvement in safety it will provide. Before acceptance by the Army, vigorous static and

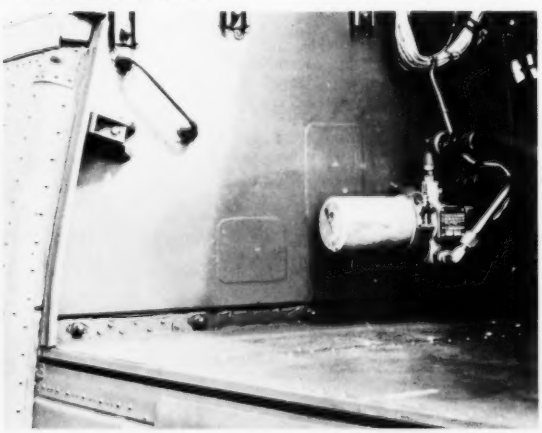


NONCRASHWORTHY
7 Bolts Placard 220 US Gal.

FUEL FILLER RECEPTACLE

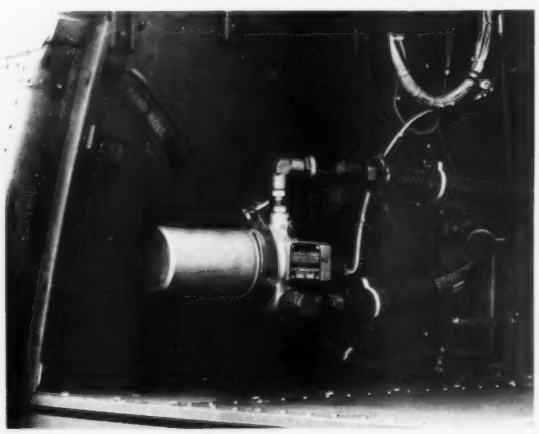


CWFS
14 Phillister Head Screws Placard 209 US Gal.



NONCRASHWORTHY
Inboard Left Engine Deck

MAIN FUEL FILTER



CWFS
Outboard Left Engine Deck

dynamic tests had to be conducted and specified performance requirements met. But the real proof comes from performance in the field.

During the period 23 June through 31 December 1970, CWFS-equipped UH-1H helicopters were involved in 12 major accidents, 14 incidents, 10 forced landings and 27 precautionary landings. There were also three helicopters destroyed and four damaged from combat. The total number of mishaps occurring during this 6-month reporting period was 70. Fuel leakage occurred in only two of these mishaps. In one, fuel leaked out of the fuel vent system after the helicopter hit a tree and came to rest partially inverted. Specific and detailed information was reported. As a result, we were able to make a recommendation for a positive fix for this type of fuel leakage problem. We are seeking additional information for the second mishap involving fuel leakage. In addition to these two, there was an accident involving fire. The helicopter, on a combat mission, was struck by enemy fire in the engine area and subsequently crashed and burned.

An analysis of available information for the major accidents and combat destroyed helicopters indicates that seven would most likely have resulted in fire if the helicopters involved had not been equipped with crashworthy fuel systems. There were no fatalities and no thermal injuries in any of the seven accidents.

In summation, presently available statistics and mishap information show the CWFS is performing as well or better than expected. This does not mean there is no room for improvement. As

Instrument panel photograph shows location of CWFS decal on retrofit UH-1 helicopter

UH-1 CRASHWORTHY FUEL SYSTEM

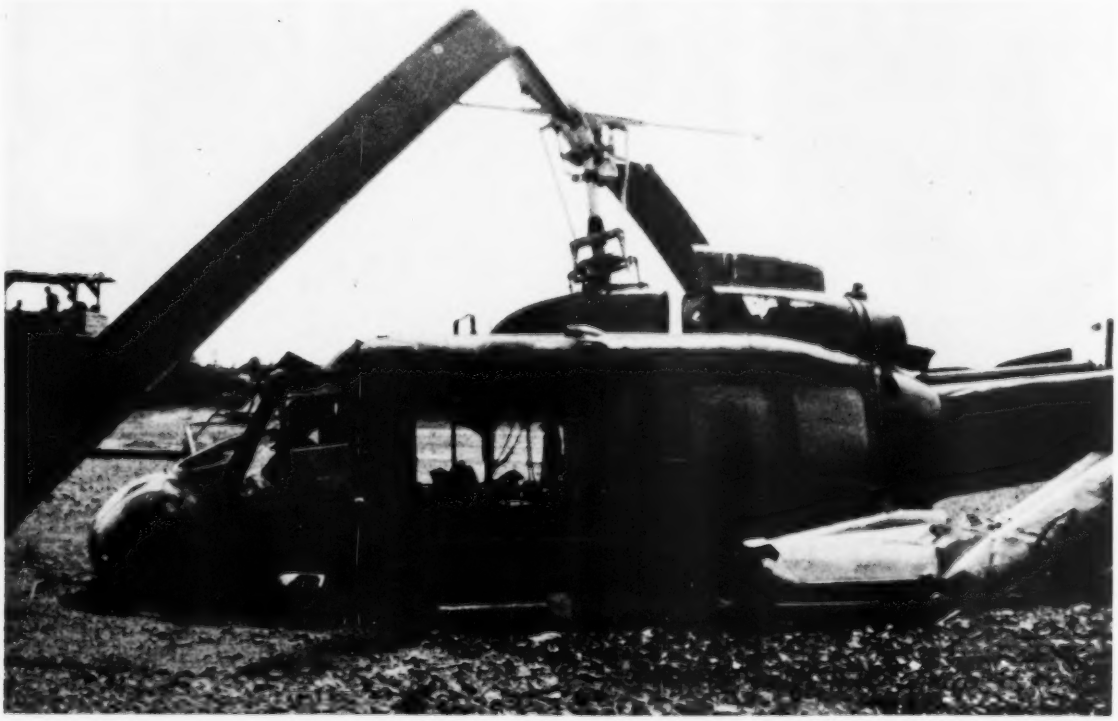
Presently available statistics and mishap information show the CWFS is performing as well or better than expected . . .

pointed out above, recommendations to improve fuel containment can be made and safety further enhanced through accurate data reporting. This requires the cooperation of commanders, safety personnel, aviators and maintenance supervisors.

USABAAR Form 57-70, Crash Performance Report of UH-1D/H Crashworthy Fuel System, dated 30 July 1970, has been developed for use by personnel in the field to report CWFS-equipped UH-1D/H mishap data of all types. These forms were initially distributed to major commands in July 1970. Further distribution was then made to the division and brigade level in RVN. To date, only a few of these forms have been completed and returned. In addition, some responses to specific questions concerning mishaps have often been slow in arriving. Others have apparently been ignored. USABAAR and other DA agencies require full and accurate information from those reporting mishaps. Full use should be made of paragraph 16 of crash facts messages and USABAAR Form 57-70 when reporting specific data. If your unit has CWFS-equipped helicopters and USABAAR Forms 57-70 are not on hand, check with your headquarters. If, after checking, you cannot obtain them, write:* Director, USABAAR, ATTN: BAAR-RA-U, Fort Rucker, Alabama 36360.

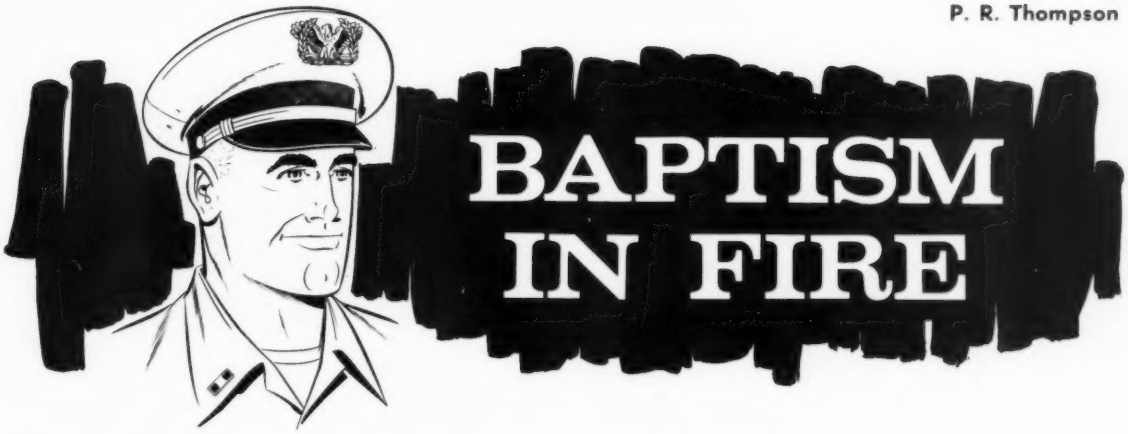
The CWFS is a well designed, reliable system. Do your part to report performance and/or deficiencies, which will enhance expansion of the CWFS program to other Army aircraft. Remember, it could save *your* life.

*Direct communication authorized by AR 15-76



This UH-1H, equipped with a crashworthy fuel system, was on a night Hawk mission when the aircraft commander heard a loud noise and the engine failed. The helicopter was autorotated into trees, landing with a hard impact which resulted in major damage to the fuselage. There was no fire.

P. R. Thompson



BAPTISM IN FIRE

THE YOUNG WO1 spoke into the telephone, "Hi, Dad. Horace. I didn't have time to write, so I thought I'd give you a ring. I got my orders for Vietnam today and I'm to be there next week. Fast work, huh?"

"About par for the course," answered Horatio Frozzleforth, self-acknowledged world's greatest aviator. "Sure wish there was time to give you the benefit of my vast experience and advice about the situations you may encounter over there. My expertise might serve you in good stead. Keep me posted on how you're getting along. If you should need any of my vast knowledge, don't hesitate to ask."

"Thanks, Dad. I've got a lot of things to do, like clearing the post and all. Take care of yourself and I'll see you in about 13 months. So long."

WO1 Frozzleforth boarded a DC-9 at the Dothan airport for the 30-minute flight to Atlanta. There he had a 2-hour layover before his flight to San Francisco. "Might as well look for something to read," he muttered. Scanning the newsstand bookracks, his eyes fell on a book entitled, "It Doesn't Matter Where You Sit," telling of air disasters, why and how they happen, and the menacing future of air travel. Sounds interesting, he thought. Horace bought the book and looked for a quiet area in the crowded Atlanta terminal. Not finding one, he slumped to a seat beside the rail in the waiting area, watching people scurrying in every direction and listening to the airlines call their arrivals and departures.

Horace's eyes brightened and he straightened as a group of stewardesses came through the concourse with an airline crew. He admired their trim figures and silently thanked their airline for refusing to follow the dress designers' plea for midis or maxis. His eyes followed them as they moved into the crowded terminal. Finally, he heard a voice announce, "Delta flight 817 now ready for boarding at gate 46."

Horace grabbed up his gear and hurried through the concourse to the gate where he boarded a DC-8. He found a seat in the tourist section, pushed his gear underneath and sat down, buckling his seatbelt.

As the jet engines whined to life, two stewardesses moved through the cabin. One stopped beside Horace. "Name please?"

"Frozzleforth."

The stewardess did a double take, staring at him with her mouth open. "Oh no!" she exclaimed. "Not another Frozzleforth! Please don't tell me you're related to Horatio."

"He's my father. Why, is something wrong?"

"No, I'll just put you down as Smith so the captain won't know we have another Frozzleforth aboard."

"What did my father do?"

"The last time he flew with us, he insisted on going to the cockpit to tell the captain how to fly. When we wouldn't let him, he kept sending nasty notes to the captain about his flying. We made an unscheduled landing at Dallas to throw him off."

"That's my father," Horace laughed. "But you won't have that trouble with me. I'm the quiet type."

Four hours and 30 minutes later, Horace stepped out into the bright California sunlight. From there, he boarded a military chartered jet en route to his final destination, via Hawaii and Guam.

With about 13 hours of flying ahead, Horace took the book out of his duffle bag, lowered the back of his seat and began reading. He became so

BAPTISM IN FIRE

engrossed in the accounts of commercial aircraft accidents that they were letting down for Hawaii before he realized it. After refueling, the jet took off for Guam, where it was refueled again before the last leg of the flight.

The big jet came to a halt at the Saigon airport and Horace followed the other passengers to the ground, stretching his cramped muscles. Since he didn't have to report until the next day, he rented a room at the American Hotel, had a hot bath and went out to sightsee. Downtown Saigon was booming, but it was different in the outskirts where Horace saw half-starved looking people living in shanties made of old gasoline cans. Conditions like these make me glad I'm an American, he thought. If people back home think they have it rough, they should see this place.

The next morning, when Horace reported in, he was assigned to the 202nd Medical Company and was soon on his way by bus. Reporting to the company commander, Horace snapped to attention and saluted. "WO1 Horace H. Frozzleforth reporting, sir!"

"At ease, Mr. Frozzleforth," replied the tired looking young major. "We're glad to have you with us. We're short of pilots so we'll be keeping you busy. I'll have the operations officer give you a briefing and he'll show you around and introduce you to the guys."

"Thank you, sir."

Horace spent a busy 2 days, then was called out on a medevac mission his third day with the company. A UH-1H had been downed by enemy fire over heavily vegetated terrain and the pilot and gunner were seriously injured. Finding an area large enough to put their Huey into presented a problem, but Horace's aircraft commander picked a site barely large enough to get the helicopter in and put it down. Knowing dan-

ger threatened from all around, Horace hurried out to help the medevac attendants with their litters. As the last litter was being lifted in, enemy fire struck the fuselage.

"Let's get the hell out of here or we'll never make it back," yelled the aircraft commander above the noise of the helicopter and the enemy gunfire.

"We're ready!" Frozzleforth shouted, climbing into his seat.

The aircraft commander applied pitch, climbed steeply to 2,000 feet and headed for home.

"That was a close shave," Frozzleforth said, wiping sweat from his forehead.

"That's a daily occurrence around here," replied the aircraft commander. "You'll get used to it. Just because you're flying a medevac ship doesn't mean a thing. Charlie could care less about the Geneva agreement."

It took only 2 weeks for Horace to realize the CO wasn't kidding about keeping him busy. He flew several missions daily, some easy, some tough. Returning from a flight, he was summoned to the operations hutch where the operations officer told him, "We're extremely short of pilots, so you'll be flying as aircraft commander today. You'll fly to the area 5 miles southwest of LZ Stratford to pick up an abandoned child, then return to the LZ for a malaria patient. Here's a rough sketch I've drawn of the area where the child is located. There hasn't been any activity there for 2 days, so I don't expect you'll have any problems. Any questions?"

"No, sir."

Horace was back on the flight line in 10 minutes and found his crew waiting. He made his preflight, strapped in and ran through his checklist. With all engine instruments in the green, he took off and flew to his first destination.

Enroute, Horace encountered scattered clouds at 500 feet, broken cloud cover at 700 to 800 feet and heavy rain in places. The visibility was very bad in the areas of heavy rain and Horace was forced to fly low level to keep the ground in sight. The site of the first pickup was in a valley surrounded by a 700-foot ridgeline. The peaks of the ridgeline were in the clouds. Frozzleforth spotted the opening he was seeking, let down and landed.

The medic found the child and brought it aboard. Horace lifted off and accelerated in a left turn to climb over the ridgeline to the northeast toward LZ Stratford. He was about 500 meters from the lowest hill in the ridgeline when a .30 caliber enemy round exploded through the plexiglass and jammed in the collective servo, causing the engine torque to reach 40 pounds. The crew chief and medic opened fire with their M-16s as Horace banked steeply to the left around a hill, then right toward the back side of the hill. As he reached the back side, the hydraulics failed completely and he couldn't budge the collective.

The chopper entered the 700-foot cloud layer and was rapidly approaching a very undesirable altitude of 850 feet with an air speed of 125 knots. Horace knew that if he raised the nose and slowed the air speed, he would surely go IFR with no means of getting down. As soon as he cleared the top of the ridgeline, he started rolling off throttle to stop the rapid climb. Suddenly, he had a retreating blade stall and momentary loss of control. It was impossible to reduce rpm with pitch because of his high air speed, so Horace decreased throttle and the rpm bled to between 5500 and 5800. The helicopter nosed up to the left, then went into a spinning dive at 140 knots.

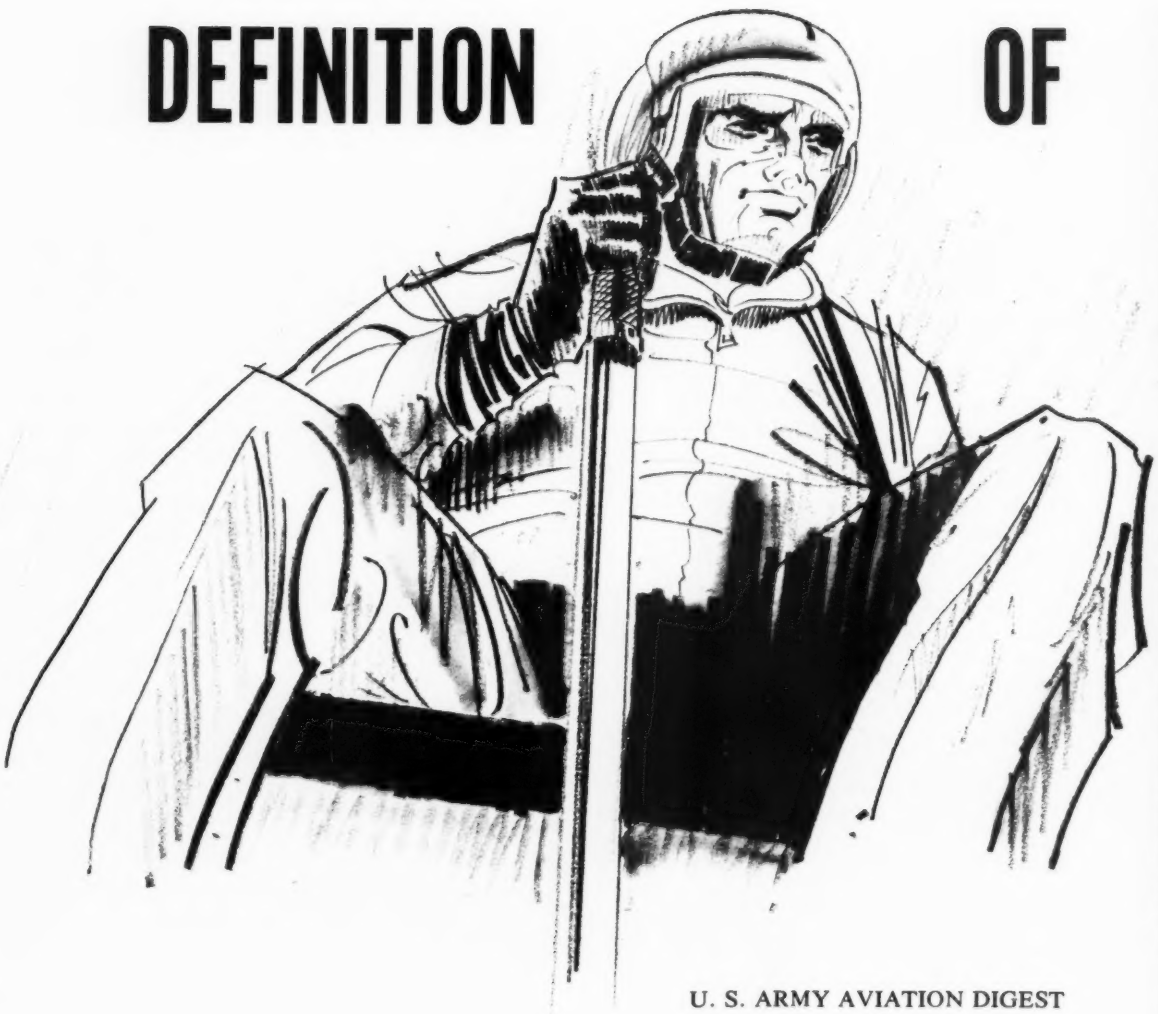
Horace rapidly closed the throttle and moved the cyclic in the direction of the spin to stabilize the helicopter. Due to the reduction of rpm and Horace's almost full weight on the collective, it lowered and the torque reduced to 25 pounds. Horace reoriented himself in the heavy rain and headed for the nearest airfield. His pilot, who had been calling the airfield, finally made contact and explained their emergency. The airfield was cleared and the tower operator stated that fire engines and ambulances were standing by. He reported all traffic cleared for 10 miles to the east and west parallel runways.

Reaching the airfield, Horace knew he was in for more trouble. Ground fog had started rolling in from the South China Sea. From 250 feet, he could barely see the approach lights. He overflew them and made a 180-degree turn to approach in the opposite direction. The rpm reached 5600, with a sink rate of 100 fpm. As Horace rolled off throttle, he came back on the cyclic, reducing the air speed to 40 knots and slowing his descent. Suddenly, he spotted a C-130 taxiing on the runway toward him. At very low level, he crossed over to the parallel runway and barely had time enough to line up when the helicopter touched down at 40 knots. He kept enough rpm to maintain directional control, bleeding off just enough to stop.

As Horace and his shaken crew and passenger got out, some Air Force men greeted them. "What's the big deal?" one asked. "Doesn't look like there's anything wrong with your helicopter to me!"

Horace gritted his teeth and forced a smile. "Of course not," he growled. "We were just practicing our emergency procedures!"

DEFINITION OF



From Army-Navy Joint Report NAMRL-1107, USAARL Serial No. 70-14, by

W. Carroll Hixson
Jorma I. Nixen
Emil Spezia

ORIENTATION-ERROR ACCIDENTS

FIRST, THE TERM *orientation* is considered to involve the correct determination of the dynamic position and attitude of an aircraft in three-dimensional space. The key word here is *dynamic*, which implies that full knowledge of the motion as well as static attitude or position of an aircraft is required to define its instantaneous spatial orientation. For a pilot to have a full comprehension of his orientation, it is essential, for example, that he be able to describe the static pitch and roll attitude of his aircraft relative to some external reference such as the earth-vertical defined by the gravitational vector; his yaw attitude relative to some geographical heading; the linear velocity of the aircraft, with or without attendant linear acceleration, in terms of forward, left-right and up-down motions; and the angular velocity of the aircraft, with or without attendant angular acceleration, in terms of roll, pitch and yaw rotary motions of the aircraft. Thus, for a fully oriented fixed wing aircraft pilot, typical information inputs would include knowledge of the forward speed of the aircraft, the vertical speed in terms of either climb or descent rates, sideward drift velocity, pitch and roll attitude, as well as bank angles, angle of attack, etc. In landing or rendezvous operations, recognition of the effects of these aircraft motions on absolute distance must be made to ensure that the aircraft does not undershoot or overshoot a preselected touchdown or rendezvous point.

The rotary wing aircraft pilot requires similar information. However, during low level hovering conditions, additional information is required in the form of linear velocity in the backward as well as forward direction. Unfortunately, the majority of the currently operational helicopters do not have instruments that provide this backward velocity or, for that matter, sideward drift velocity, information. The usual lack of short-range radar altimeters in helicopters is another problem confronting the rotary wing aircraft pilot during low level operations performed with poor ground visibility.

By this definition of the word orientation, it follows that a pilot will be considered to have made an orientation error whenever his perception of the motion and attitude of his aircraft differs from the true motion and attitude, i.e., the true orientation of the aircraft. The exact magnitude of an orientation error will obviously vary over a wide range.

In the case where a pilot suffers severe vertigo and completely loses all perception of either aircraft motion or aircraft attitude, the probability of a large-scale orientation error is high, as is the probability of an accident if the disorientation is prolonged or is experienced at a critical control phase within the flight. In another case, the pilot may sense or feel that the aircraft is climbing or turning when in actuality it may be flying straight and level. If during this disorientation experience the pilot accepts that his sensations define the orientation of the aircraft, then an orientation error

DEFINITION OF ORIENTATION-ERROR ACCIDENTS

. . . a pilot will be considered to have made an orientation error whenever his perception of the motion and attitude of his aircraft differs from the true motion and attitude . . .

is present. However, if he realizes that his sensations are in conflict with another input, say the aircraft instruments, and intellectually arrives at the correct judgment of the true motion and attitude, then though the pilot is experiencing disorientation, an orientation error does not result.

Initially, then, an orientation-error accident can be defined as one that occurs as a result of an incorrect control or power action taken by a pilot due to his incorrect perception of the true motion and attitude of his aircraft. Using this definition, an accident classifier can place primary emphasis on determining whether or not the accident involved an erroneous judgment of orientation on the part of the pilot. It follows that questions pertaining to the causes of the orientation error, or its manifestation to the pilot, need not be immediately answered during the initial classification.

There must, however, be several qualifications to this definition. For instance, the accident situation must be one in which the demands on pilot skill are reasonable. To illustrate, consider a helicopter pilot who has a main rotor strike as a result of landing from a hover in a nonlevel attitude, say with an excessive roll angle. This is an orientation-error accident involving incorrect perception of aircraft attitude.

The causes of the orientation error could be much varied, ranging from inattention to instruments, a tilted horizon line, visual illusions produced by a nearby moving aircraft, or distraction. A simple, but essential, assumption is that the pilot did not deliberately fly his aircraft into the ground. However, if in a similar landing from a hover situation, a nearby helicopter flies over the given aircraft and produces severe rotor downwash or turbulence, and the end result is a similar rotor strike, the accident would not be classified as an orientation-error accident.

It is not reasonable to expect the pilot to maintain both perception and control of aircraft orientation under these conditions. In like manner, a tail rotor strike resulting from excessive flare applied by the pilot in a landing formation to avoid striking another aircraft making an unauthorized takeoff would not be classified as an orientation-error accident. But again, if this tail rotor strike occurred during a routine uninterrupted landing, it would fall into our classification since the pilot's perception of closing rate or pitch angle was incorrect.

A further qualification involves accidents associated with navigation errors. Though knowledge of heading is pertinent to orientation, accidents involving navigation mistakes, and only navigation mistakes, are not classified as orientation-error accidents. That is, if a pilot strikes a hillside as a result of flying a course of 100 degrees instead of 200 degrees, the error is one of navigation, not orientation. In this respect, the word *misorientation* has received some usage to account for navigation errors. However, if in addition to being on the wrong course or heading, a pilot is having difficulty controlling his aircraft and an accident results because of this difficulty, an orientation-error accident classification would generally result.

Accidents resulting from collision with unseen objects, e.g., a wire strike, are also not included if the collision occurs during normal controlled flight. However, if a hovering pilot allows his aircraft to drift backward, without detection, and finally to impact against an unseen object, an orientation-error classification would result. That is, collisions of this sort are included only when they derive from an orientation error.

As qualified by all of the above, an orientation-error accident is thus said to occur whenever an accident results from a pilot's incorrect perception of his true motion and attitude in space. The orientation error may range from a complete loss of all knowledge of orientation to simple confusion as to only one of the many motion and attitude parameters required to be recognized by the pilot. Or, as mentioned previously, the pilot may never realize that the motion or attitude of his aircraft is gradually changing so as to be soon unfavorable to safe flight.

The Use of Army Rotary Wing Mishap Experience to Assure Improved Product Effectiveness

Adapted from a paper presented at the Ninth Reliability and Maintenance Conference

Lieutenant Colonel James T. Darrah Jr. and Joseph L. Haley Jr.
Plans and Programs Department, USABAAR

NOTABLE AMONG more recent activities at USABAAR is the development of a greatly expanded mishap data and information management system. This system includes completely revised mishap reporting which will provide more specific data and information needed for in-depth mishap analysis. The heart of this new system is a computer complex which will enable rapid processing of a vast quantity of mishap information. When completely operational, this system will provide a greatly expanded capability for prompt and effective responses.

Accident causes—A review of Army mishap experience has clearly shown the need for the modern system described above. This review included the overall accident prevention problem,

shown by the general trends in figure 1. The fact that accident rates of the Army and other services have leveled off in recent years has been well publicized. The cause for this has been attributed to a tendency for accident prevention measures to stagnate after earlier dramatic successes brought about by the prevention measures. This reduction in rate may have been considered good enough were it not for the factors shown by cost and exposure curves. While the rate has remained essentially constant during the past several years, there has been a steadily increasing impact of mishaps in terms of costs and combat readiness. As long as we must acquire and operate increasingly sophisticated and costly aircraft systems to accomplish our missions, we must continue to explore ways and means to prevent accidental losses of aviation resources. We cannot afford to do less.

A basic philosophy of accident prevention is that once causes of mishaps are determined, corrective actions to eliminate the causes or prevent recurrence can logically follow. The fact that we must continue to refine our capability in this area is indisputable. The new automatic data processing (ADP) system at USABAAR is a big step in this direction. But we can't wait for the new system to give us better answers in the future. Action can and must be taken now, using available information.

To further define and narrow the problem, a summary of established helicopter accident cause factors for FY 1969 is shown in figure 2. This is a partial listing which does not include suspected cause factors or losses due to combat action. Neither does it include command and supervision errors, maintenance errors and other factors which contribute only 8.4 percent of total cause factors. The percentage values shown are a ratio of the total number of cause factors and not a ratio of the total number of accidents. This is an important distinction because more than one cause factor occurs in most accidents. The cause factors in figure 2 are briefly explained:

Crew error—Failure of crew member to cope successfully with an emergency situation.

Materiel failure—Failure of any part or component of the aircraft.

Materiel malfunction—Malfunction of any part or component of the aircraft.

Other—

Personnel—Error, by personnel other than the crew.

Training—Existence of training deficiencies.

Facilities—Inadequate landing areas, etc.

Design—Aircraft controls orientation, etc.

At first glance, it may appear that crew error is by far our greatest problem and that materiel failures and malfunctions are not as important. The often intangible interrelationship of cause factors, however, is not apparent in this summary. Not fully understood or documented is the influence which materiel failure, malfunction or design deficiency has on crew performance under emergency conditions. USABAAR is working on this problem and, hopefully, these factors can be shown in better perspective in the future.

Materiel failures—Materiel failures, malfunctions and the less well defined factor of materiel design all play important roles in Army helicopter accidents. This article concentrates on the materiel failure aspects of accident prevention, but the close interrelationship of this factor with man, environment and management must be kept in mind.

Powerplant failures—One of the causes of engine failure in Army helicopters has been the fourth stage compressor rotor of an axial flow turboshaft engine. The failures have occurred at the base of the triangular slot provided to retain the compressor blades in the rotor, as shown in photos 1 and 2. These failures have been caused by a combination of high stress, temperature, corrosion and fatigue in the aluminum material. This problem has been a factor in more than 70 accidents from an operating fleet of approximately 3,000 helicopters.

Postaccident analysis of these failures indicated this particular aluminum was a marginal material for application at the temperature and stress levels existing in this higher powered version of an older engine. Why, then, was it used? It was used because it had performed satisfactorily in this same engine type/series for 10 years, as shown in table 1, and because the incremental increase in pressure ratio, temperature and rpm should not have caused a problem. However, not enough attention was given the fact that the engine was to be used in a heavier helicopter and the *average* power required to sustain cruise flight was approximately 30 percent greater than in the original application.

A complete analysis of this component prior to production would have revealed the need to either change the design or the material. This component failure is an example of the expensive *fly-fix-fly* philosophy. It is also an example of the aircraft (weight) growth syndrome being followed without due concern for component redesign.

Power train failures—These include any failure

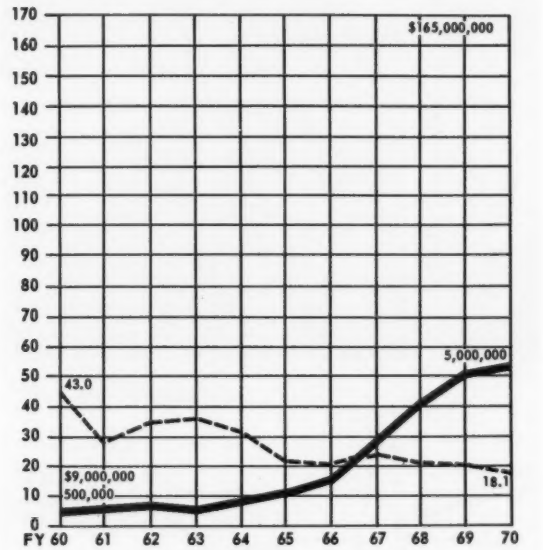


FIGURE 1
Worldwide Army R/W Accident Experience (11 Years)

A basic philosophy of accident prevention is that once causes of mishaps are determined, corrective actions to eliminate the causes or prevent recurrence can logically follow

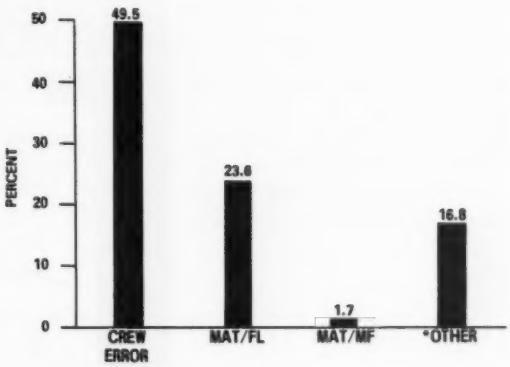


FIGURE 2
Established R/W Accident Cause Factors FY 69 Worldwide

*Personnel, Training, Facilities, Design

occurring between the power plant and the main rotor(s) or tail rotor. All Army helicopters transmit engine torque to the main and tail rotors via mechanical shafting. These shafts vary from 2 to 20 feet in length and rotate at speeds up to 6000 rpm. The problem of transmitting torque through these shafts is further complicated by the fact that bearing supports displace relative to each other as aircraft structures deflect due to aerodynamic loads. The shafting dynamics problem has resulted in the coupling of relatively short shaft lengths (60 inches maximum) to provide for rotational stability and allow for support displacement. This requires the use of flexible couplings at each support point. These couplings have been responsible for a large number of mishaps, detailed as follows:

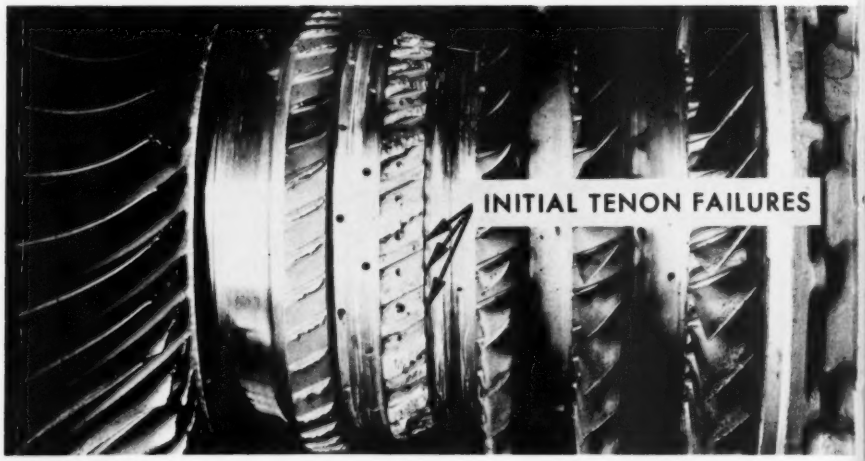
Drive shaft coupling/support failures—For most single rotor helicopters, the flexible tail rotor support boom uses several flexible couplings and support bearings. This type of coupling/support should be relatively easy to design since the same type of device has been used in the automobile for many years. Nevertheless, in a recent 3-year span, this coupling support has been a factor in 68

TABLE 1
Turboshaft Engine Growth History

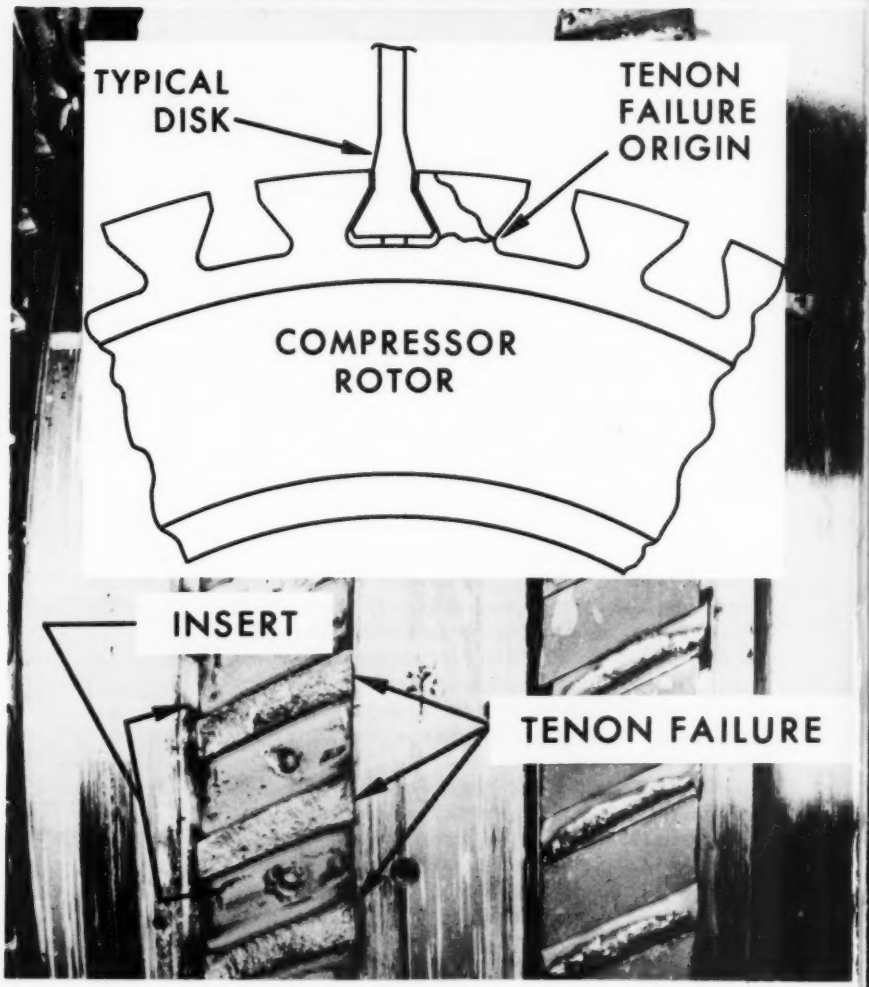
SERVICE INTRODUCTION	1958	1961	1963	1967
HORSEPOWER*	100%	105%	129%	165%
COMPRESSOR RPM IN THOUSANDS	24.2	24.1	24.4	25.4
COMPRESSOR PRESSURE RATIO	6.0	6.0	6.2	7.6
AIRFLOW IN CU FT/SEC	10.4	10.4	10.6	12.2

*Assume original engine horsepower equals 100 percent

IMPROVED PRODUCT EFFECTIVENESS



PHOTOGRAPH 1
Turboshaft engine compressor failure (overall view)



PHOTOGRAPH 2
Turboshaft engine compressor rotor failure (detailed view of failure origin)

accidents out of a fleet of approximately 4,000 helicopters. Figure 3 shows this coupling/support as it is installed in the 4,000 helicopters. Note that 13 parts are required for the shaft support and coupling. The basic function of the coupling/support is (1) shaft misalignment compensation, (2) bearing support, (3) shaft elongation compensation and (4) torque transmission. Basic reliability criteria were violated in this design (i.e., too *many* parts had to be fitted and lubricated *properly* to permit *trouble-free* operation). Photo 3 shows a typical failure in the support bearing of this type coupling.

Bearing failures are caused many times by infrequent or inadequate lubrication in a dusty environment. Photo 4 shows a typical failure in the flexible gear coupling which is also caused in many cases by infrequent lubrication or lubricant loss.

In contrast to the flexible gear coupling, the flexible plate coupling shown in figure 4 is also used. Note that only eight different parts are used, although the same functions are performed. This flexible thin plate coupling consists of 10 to 20 stacked washers (item 3) connected to three-prong fittings on either side. The flexible plate coupling is used in more than 1,000 Army helicopters and is performing much better than the gear coupling/support shown in figure 3. The flexible plates can be visually inspected for fatigue cracks. At least one-third of the plates must fail before the coupling strength equals the normal operating loads. The flexible plate coupling is a good example of fail-safe design, since more than one plate must fail before the entire stack fails. Maintenance of the plate coupling is relatively easy because it can be visually inspected for fatigue cracks and requires no lubrication.

Oil starvation due to Murphy's Law—Maintenance personnel must be constantly on guard to ensure that parts or components are installed correctly. The consequences of incorrect installation of a specific component can be catastrophic. This is particularly true with the oil supply for engine(s) and transmission(s). A recent example involves an engine oil line check valve which is located in a straight fitting with male threaded ends. The fitting is identified as to the direction of

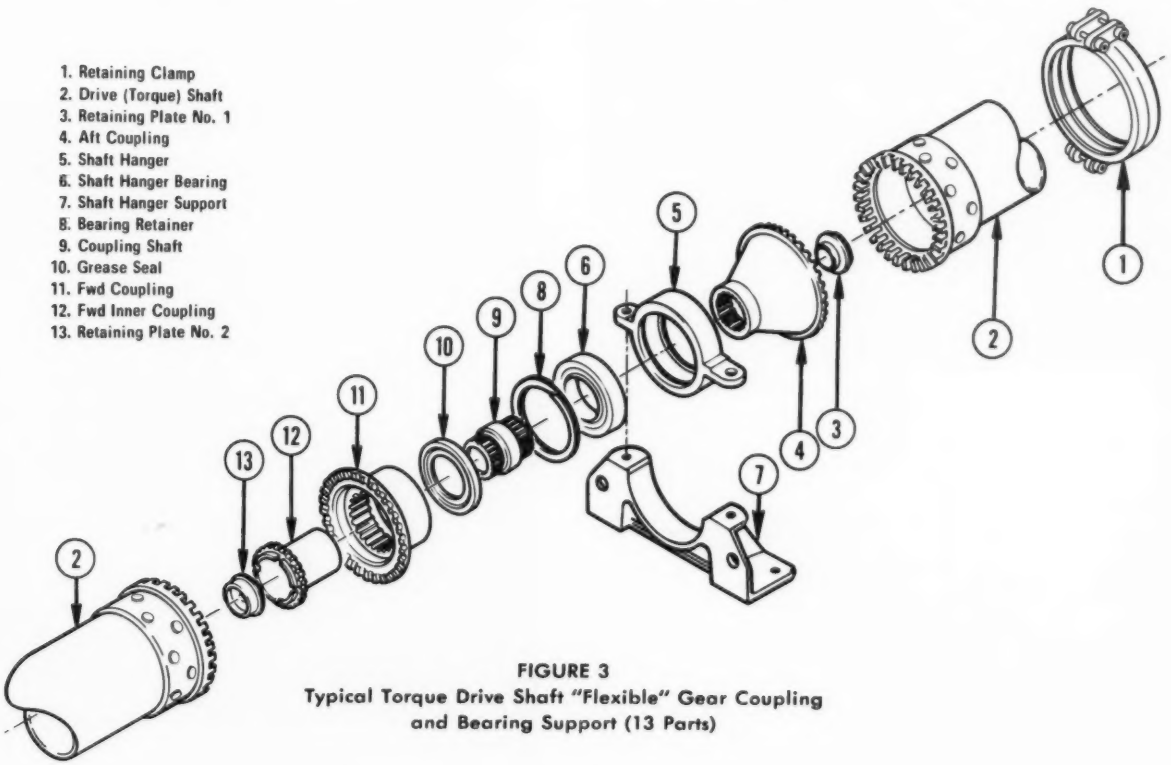
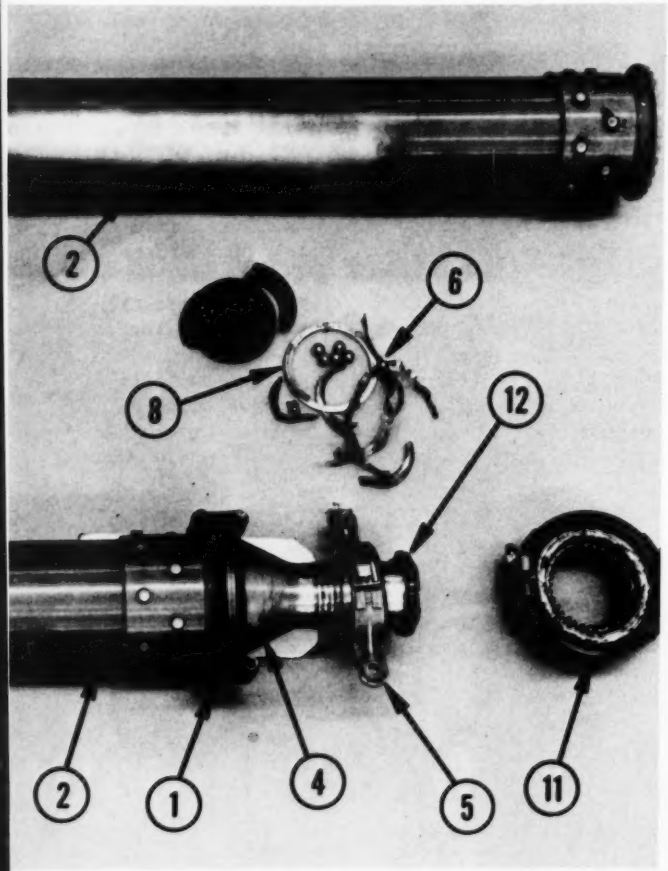


FIGURE 3
Typical Torque Drive Shaft "Flexible" Gear Coupling and Bearing Support (13 Parts)



PHOTOGRAPH 3
Typical bearing (part #6) failure

oil flow, but it can be installed in either direction since the threaded ends of the fitting are identical. Even though the flow direction is marked, a new mechanic may not *know* the direction that the oil should flow. Of course, reversed installation results in oil starvation to the engine bearings and very rapid engine failure. This is a good example of a simple component which can be incorrectly installed and cause an accident. The best remedy for this problem is the positive prevention of reverse installation by a change in the part geometry. Until the design is changed, heads-up maintenance is necessary.

Rotor system failures—From the helicopter's beginning, cyclic and vibratory loads applied to rotor systems have presented designers with very taxing problems. Increased unit payloads and forward speeds have only increased these problems. Materiel fatigue in these systems has received close attention. As a result, the Army has suffered few pure fatigue failures in the *major* components (i.e., main and tail rotor blades, main rotor shafts, etc.). It would appear that reliability

PHOTOGRAPH 4
Typical female gear (part #11) failure

engineers have performed their function well in most of the major components. However, several examples of catastrophic failure at the interface between main and tail rotor blades and their connecting fittings mar the excellent performance of the blades.

Tail rotor center hub yoke failures—One Army helicopter design had 29 failures of the basic component which ties the tail rotor blades together. These failures resulted in 29 major accidents and 32 fatalities in a fleet of approximately 3,000 helicopters. The basic parts are shown in photo 5. The central hub or yoke must carry the bending loads of the blade aerodynamic forces, as well as the centrifugal loads due to rotation. In addition, the yoke must permit enough blade feathering to provide the variable aerodynamic forces needed for all flight conditions.

In Army service, the thrust and radial bearings shown in photo 5 have seized on occasion. However, the catastrophic failures have been caused by a tensile failure of the yoke's threaded end, as shown in photo 6. As can be seen, the failure originated in an area of high stress concentration at the thread root and safety pin hole intersection. This type of failure results in the loss of the entire tail rotor and/or tail boom due to rotor imbalance. When this happens, the helicopter crashes due to *complete or partial control* loss. Improper maintenance, such as inaccurate balance, blade tracking or assembly technique has undoubtedly played a role in some of the yoke fatigue failures. However, the design contains too many potentially hazardous features. For example, the tail rotor (1) is a cyclicly loaded component, (2) cannot be visually inspected, (3) contains severe stress concentrations and (4) can lead quickly to catastrophic consequences when failure occurs.

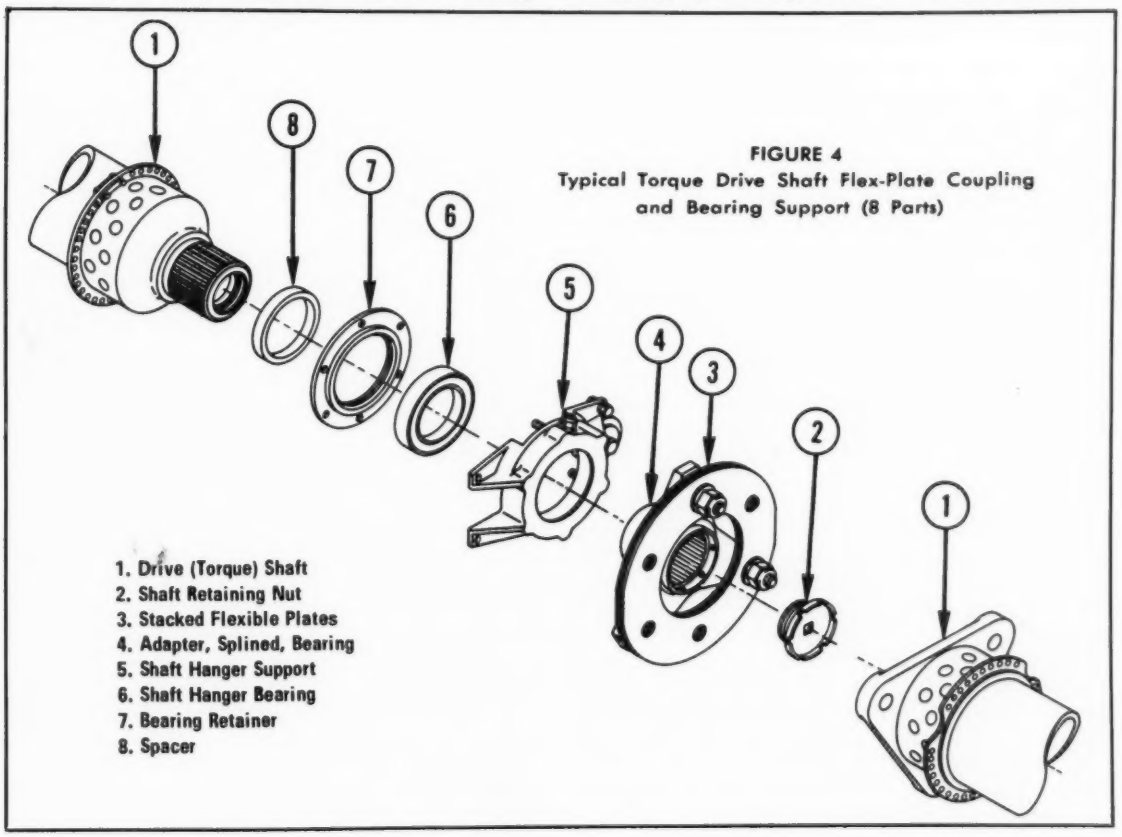
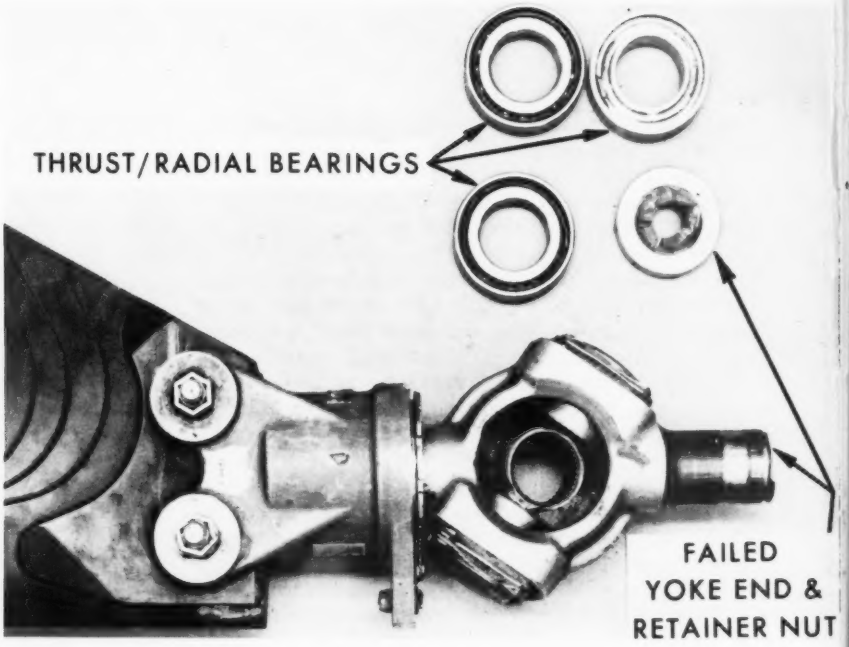


FIGURE 4
Typical Torque Drive Shaft Flex-Plate Coupling and Bearing Support (8 Parts)

IMPROVED PRODUCT EFFECTIVENESS



PHOTOGRAPH 5
Tail rotor blade connector (yoke) failure at threaded end (overall view)

As a result of the condition described above, the yoke has been redesigned so that tensile loads are carried by a built-in shoulder and split collar on the yoke. However, some fatigue failures have now occurred in the blade grip (the bearing containing collar which connects the yoke to the blade). This approach should be abandoned in favor of a complete hazard analysis (to be discussed later) of the tail rotor system. It is suggested that tail rotor hubs be designed in a way similar to main rotor hubs, since both serve very similar functions. This torsion-tension function is served in the main rotor of most helicopter designs by the use of laminated flat plates or strands of wire. The flexible plates or wires sustain the tensile loads and permit blade feathering, while the torque and bending loads are carried by separate components. The main point is that tensile loads are carried by a multiple load path structure, while bending loads are carried separately. This type of attachment improves reliability of the system because it is easier to locate fatigue crack origins.

Main rotor blade spar fatigue failure—An identical failure of the main rotor blade in one model helicopter has resulted in three catastrophic accidents. The details of this design deficiency are presented, hopefully, to prevent a similar failure in new helicopters. This failure has occurred at the juncture of the blade spar with the main rotor hub. The spar is threaded into a cuff (collar) fitting and the cuff is pivoted about a vertical axis on the hub. A torque retention hole is drilled through the cuff and spar. The failure originates at the retention pin hole of the main spar cuff retainer, as illustrated in photos 7 and 8.

These failures have been caused by normal geometrical stress concentration and by the inclusion of metal (drilling) chips at the bolt and cuff interface. Installation gouge marks are also believed to be responsible for added stress concentration. An interesting design factor is the orientation of the retention pin *parallel* to the lifting axis of the blade rather than *perpendicular* to that axis (i.e., in the rotor disc plane). One reason for the vertical positioning of the bolt was to prevent it from falling out of the hole in case of nut loss, normally a desirable feature. The effects of stress concentration due to a hole in the hub material would be less along the hub's neutral (unloaded) axis, however, than perpendicular to the neutral axis. This example illustrates the point that designers must consider not only the flight environment, but also maintenance and assembly environments.

In this case, the design was proven to be adequate by simulated flight test conditions for a specified number of flight hours. However, the fatigue life of the hub with a higher degree of stress concentration (caused by drill chip inclu-

PHOTOGRAPH 6
Tail rotor blade connector (yoke) failure at threaded end (closeup view of fatigue crack through threads and drilled holes)

sions and gouge marks) was not determined. Two lessons are apparent from this failure history: (1) the hazardous condition probably could have been alleviated during design if it had been identified, and (2) provisions for possible misuse, misalignment or even abuse could have been accounted for in determining the fatigue life of this very critical component.

Hydraulic systems and flight control failures—Hydraulics and flight controls can logically be discussed under one topic, since a majority of Army helicopters now use hydraulic power for flight controls. Examples of hydraulic and flight control design considerations are:

1. Hydraulic system redundancy must be provided in those rotary wing aircraft which are uncontrollable without power-assisted flight controls.

2. Provisions must be made for the often extremely adverse field environment in which hydraulic systems must perform. For example, a small rod of only 0.062 inches diameter by 2.6 inches long was used to actuate a flight control valve in one helicopter. Poor quality control of the part geometry and operation in a dusty environment resulted in a misaligned and worn linkage which applied an eccentric load on the rod and caused it to fail.

3. Adequate consideration must be given to the extreme *vibration* environment of all helicopters. So-called self-locking fasteners no longer remain locked and fatigue problems are much more severe under these conditions.

This list, while not exhaustive, outlines the problem. Several examples which highlight specific failures are:

Hydraulic tubing failures—One continually pressurized hydraulic line has caused numerous leaks and failures in one helicopter design. A total of 70 failures was recorded during a 6-month period for a fleet of approximately 3,000 helicopters. This hydraulic line is installed for use with field test hydraulic units only and is not needed for flight. Since the line failure is caused by cyclic pressurization and vibration forces, it is doubtful this failure would have been predicted by a preliminary hazard analysis in view of the many unknown factors in the early stages of the design. Recent tests indicate that pump pulsation (cyclic) stresses are 80 percent of normal pressure stresses—enough to explain the numerous line failures. This pressurized and unessential line is routed so that it is approximately 5 feet long, whereas the line length could be reduced to 0.1 foot. A thorough analysis of this line during initial system design could have reduced the length of the line and provided a method to depressurize the line for flight.

Push-pull flight control tube failures—The basic push-pull control tube has been used since the advent of hydraulic-boosted control systems. Al-

though push-pull control tube failures have not caused a large number of accidents, these accidents have, to a large extent, been catastrophic. For example, the failure of such a push-pull tube has caused four catastrophic accidents in a fleet of approximately 500 helicopters. The failure mechanism is shown in figure 5. This figure shows the tube is swaged over a knurled steel end fitting. Vibration and cyclic loading over a period of time causes the tube to slip on the end fitting. Could this failure have been predicted by a complete system safety engineering analysis in the preliminary design stage? Perhaps. In any event, these failures point to a need for more realistic environmental (vibratory and cyclic) *tests* on key elements of control systems prior to service usage.

Primary and secondary hydraulics drive shaft failure—A single drive shaft is used to drive both primary and secondary hydraulic systems in one Army helicopter design. Failure of this drive shaft during cruise flight will result in a catastrophic accident, since no other system is provided for the crew to control the helicopter. Fortunately, this drive shaft has never failed in flight, but it has failed on three different occasions during ground runups. This type of design would, in all likelihood, have been changed early in the design stage if a system safety hazard analysis had been conducted, because the primary and secondary hydraulic systems are not truly redundant.

Loss of fasteners—Undoubtedly, the elimination of all fasteners in helicopters would significantly reduce the number of materiel failures and malfunctions. Unfortunately, the state-of-the-art in manufacturing techniques does not permit this solution. Although fastener failures may be either materiel failure or pin loss, only the latter is discussed.

The most common fastener loss involves the loosening of a castellated nut from a bolt because the cotter pin is omitted. A smaller number of cases involve the loosening of fiber-lined nuts which have been reused several times and the fibers have lost their grip. Although thorough maintenance could probably eliminate fastener losses, a more reliable solution would forgive human (maintenance) errors. Suggestions to prevent fastener losses include: (1) orient the bolt so the nut is on the bottom (i.e., so gravity will tend to keep the bolt in place after nut loss) and (2) provide at least two methods of nut retention (one method should not depend on human action) in all areas where fastener loss would be catastrophic.

Since the loss of fasteners in aircraft is as old as flying itself, can a solution be found? Yes. Self-locking fasteners can be developed and several types are already available. The Army is considering the installation of new self-retaining fasteners in all critical components of one helicopter design. Service usage of these new self-retaining fasteners should completely validate their effectiveness.

Materiel failure prevention—We have discussed the nature and magnitude of the overall accident prevention problem, plus some specific examples of that part of the problem dealing with materiel. However, the solution to the problem has not been fully explored.

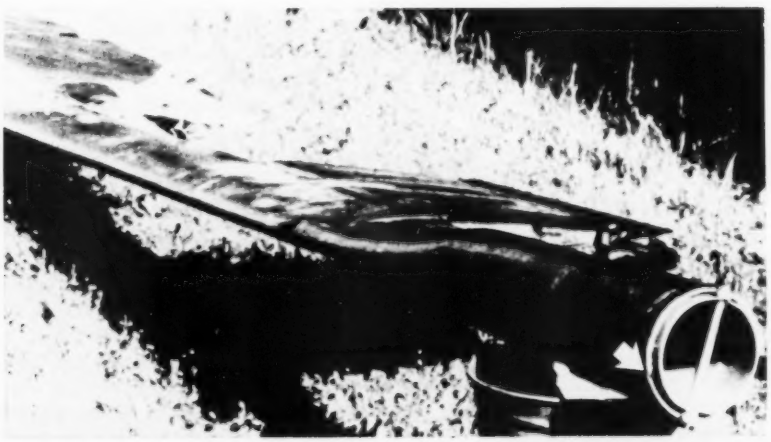
The general solution to the accident prevention problem involves a constant effort to achieve reductions. Progress must be measured in comparative values—are we doing better or worse? The solution is extremely complex, involving virtually every individual having anything whatever to do with aviation. Progress toward this solution demands the highest degree of management and technical skills to coordinate and integrate such a huge effort. However, progress can be made. We are not looking for a general solution, but for reasonable measures that can be taken to solve specific problems, such as those previously discussed.

System safety application—This evolved as a means to provide at least partial solutions to these problems. Disciplinary in nature, system safety provides a well-ordered management tool with which modern technology can be methodically and efficiently applied to eliminate or control hazards in complex systems. Standardization of system safety requirements and criteria, and hazard analysis methodology have been painfully slow in developing. Industry has also been slow in accepting and applying these new concepts. With several formal system safety programs in being, however, progress in implementing the concept is encouraging today. System safety must be vigorously applied now and in the future to bring it to maturity and realize its fullest benefits.

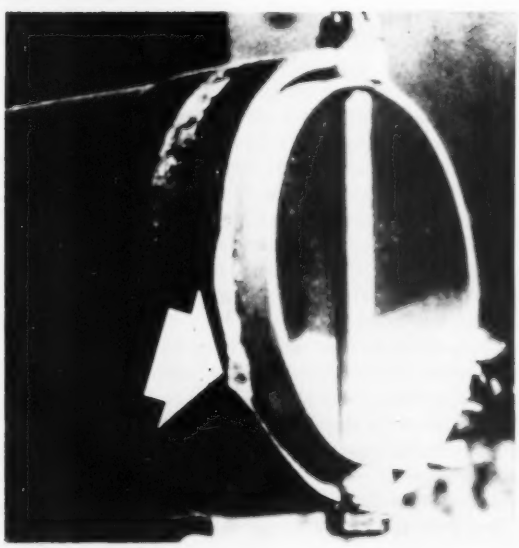
There is little question that the system safety discipline produces the greatest advantages when it is applied at the very beginning in the life cycle

of a system. This is a fundamental premise upon which the concept is based. Starting at the beginning and building on previous work is most efficient and there is a geat technological challenge in seeking to identify and eliminate hazards in a system for which there is no operational experience. This challenge is met by system safety analyses performed in a comprehensive and methodical way. While analysis gives a high degree of assurance that hazards in a system have been identified prior to use, proof of the conclusions reached in analysis must await actual operation of the system.

No analytical methodology exists which will give 100 percent assurance that *all* hazards have been identified and their consequences precisely predicted. Consequently, at some point, the system is tested to actually see if it performs as it



PHOTOGRAPH 7
Main rotor spar failure due to stress concentration at bolt hole (overall view)



PHOTOGRAPH 8
Main rotor spar failure due to stress concentration at bolt hold (closeup view)

should. Because of shortcomings in the analytical techniques used, unpredicted hazards may appear, or unexpected consequences of known hazards may occur during these tests. If an effective system safety program has been conducted up to this point, the chances are that any new hazards or consequences will be less severe. Testing seldom continues until an acceptable system hazard level is proven prior to operational use. Thus, hazard analysis must be followed by verification through operational testing or actual operational use.

The examples of materiel failures and malfunctions discussed earlier have all occurred during operational use of existing helicopters, none of which had been subjected to a system safety program. There is no ready file of previously conducted comprehensive hazard analyses on these helicopters. Existing knowledge of system hazards is based almost solely on mishap experience. Tests have rarely been performed to primarily verify the safety or hazard level of a system.

The philosophy which has been applied to these operational helicopter systems has been to use them until a mishap indicated that something was wrong. The procedures used to first *identify* deficiencies and then *develop* and *apply* corrective actions have been, at best, laborious and time-consuming. While these procedures have been underway, additional mishaps have occurred from the same deficiencies.

System safety applicability to existing helicopters—For our existing helicopter systems, are we to accept this philosophy as the best we can do under the circumstances? Are we to continue to delude ourselves into believing the system safety concept cannot be effectively applied to existing helicopters because it's cheaper not to? Is the system safety discipline *only* effective when applied at the very beginning of a system's life cycle? We maintain that the answer to all these questions is NO!

In the examples presented earlier, component design revisions were identified which hopefully would have corrected the problems. This identification of possible improvements to components is a necessary, but not final, corrective action. It is only a beginning.

The system safety process described in the May 1970 issue of the AVIATION DIGEST was developed by USABAAR to present the logical sequence of steps in attaining the objectives of system safety, regardless of position in a system life cycle or level of detail involved. The process can be applied to existing systems now, although no previous system safety effort has been performed. In fact, there are several advantages to applying the system safety concept to a system for the first time after it has been in operational use for a certain period. The actual mishap experience of the system will be known. Mishap history will include a tabulation of accidents by overall degree of severity (major and minor accidents, incidents, forced and precautionary landings) and a description of the circumstances. Actual failure rates of components will have been recorded. Causes of mishaps will also be available, although the validity of established causes will range from suppositions to well-documented proof. *Known precedent* (previous experience and knowledge) of the system is greater at this time than in the development stage because it is highly subjective and is based more on actual fact. This is the first step in the system safety process.

This knowledge has been used in the past to identify individual problem areas in a system, but there is now a need to establish realistic priorities for attacking these problems. To do this, mishap data and information must be analyzed in such a fashion as to furnish a valid answer to the question, "What is the most important problem in this system?" Given the answer to this question, the process then solves the specific problem.

Another advantage of this increased knowledge derived from actual experience is a better ability to view problems in relation with one another and define existing interrelationships. Aside from enabling the establishment of priorities, perhaps more than one problem can be solved at a time.

The remaining steps in the system safety process follow logically and further refine actions taken. We have pointed out several advantages of getting this process started in existing systems. Given a system deficiency revealed through mishap experience, this process provides a practical method for determining what system modification will most effectively correct the deficiency.

It is likely that application of the system safety discipline to existing systems will be more expensive initially. Management must make the decision whether the assurances provided by such application are worth the cost. Past experience has proven, we believe, that without this assurance, the odds are good that an individual component modification will provide only a temporary cure. An-

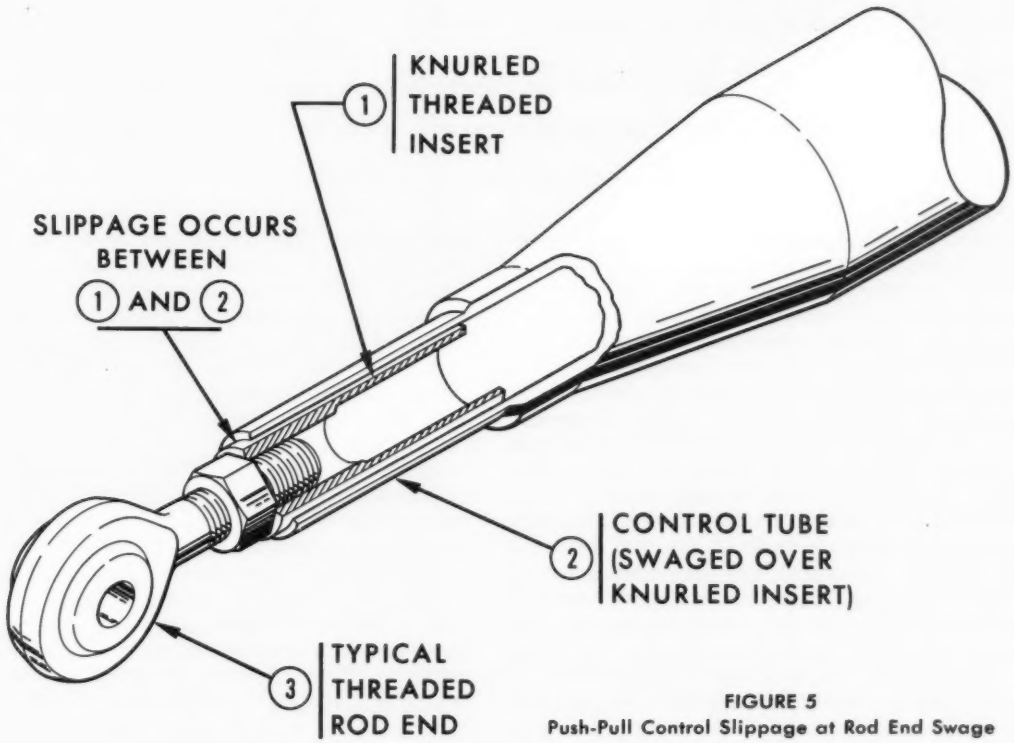


FIGURE 5
Push-Pull Control Slippage at Rod End Swage

other related problem may later creep in unexpectedly and result in further accidental losses.

If we begin to apply this concept now on each existing system in those areas where our mishap experience has shown our most serious problems lie, substantial benefits will be realized in only a few more years in the remaining life of these systems. Perhaps, eventually, there may even develop a file of comprehensive analyses which will then serve the same useful function for an existing system as the corresponding file for a system developed from the beginning under the system safety discipline.

Integration of assurance sciences—Although this article is presented from the viewpoint of accident prevention, it cannot be overemphasized that this viewpoint does not operate in an exclusive vacuum. Reliability, maintainability and quality assurance all played a part in the examples discussed. All the assurance sciences are very closely interrelated in concept and application. While we have been discussing concept, the real proof of the concept lies in its effective application. Rarely will any one assurance science have exclusive influence in decisions which affect a system. It is a responsibility of the various assurance sciences that their efforts complement one another and are performed in an integrated and coordinated manner. It is a responsibility of management to impose requirements on the assurance sciences for the management tools necessary to effectively control a complex system. Management is further responsible to provide the resources necessary for the assurance sciences to fulfill these requirements.

Conclusions—Nothing has been revealed here that is particularly new or unusual. The fact that we continue to suffer unacceptable accidental losses to aviation resources should come as no

IMPROVED PRODUCT EFFECTIVENESS

. . . when mishaps are caused by component failures or malfunctions, modifications must be designed to prevent further mishaps, not just to prevent further failures . . .

surprise to anyone. It is well known that a significant portion of these losses are due to hardware failures, malfunctions and design deficiencies. As a result of mishap analysis, detailed information on specific materiel shortcomings is provided to the responsible system manager and manufacturer. Finally, the system safety concept has been discussed at length and even practiced for several years by the government and industry. Most people agree that the effectiveness of our aviation products can be improved through safety.

With all this knowledge, the need to present it again can be questioned. The answer is that even with all this knowledge, actions being taken to prevent accidental losses are not yet producing results which can be measured in terms of a significant reduction in aviation mishaps. This is not to say that current accident prevention efforts are accomplishing nothing. It is apparent, though, that these efforts tend to hold the line rather than produce a continual improvement.

One reason for this lack of improvement may be that we overemphasize the theoretical and final no-accident goal of the future. Perhaps, in developing long-range plans, approaches and techniques to accomplish the ultimate objective, we overlook the significant things that can be done today.

We have focused on some current materiel problems. These problems are still going to be with us tomorrow unless we take action to correct them. For corrective action to be most effective, we have shown the concept of system safety must be applied in a practical manner to solve some of the specific problems. The system safety process is a logical problem-solving procedure adaptable to any point in a system life cycle and at any level of detail.

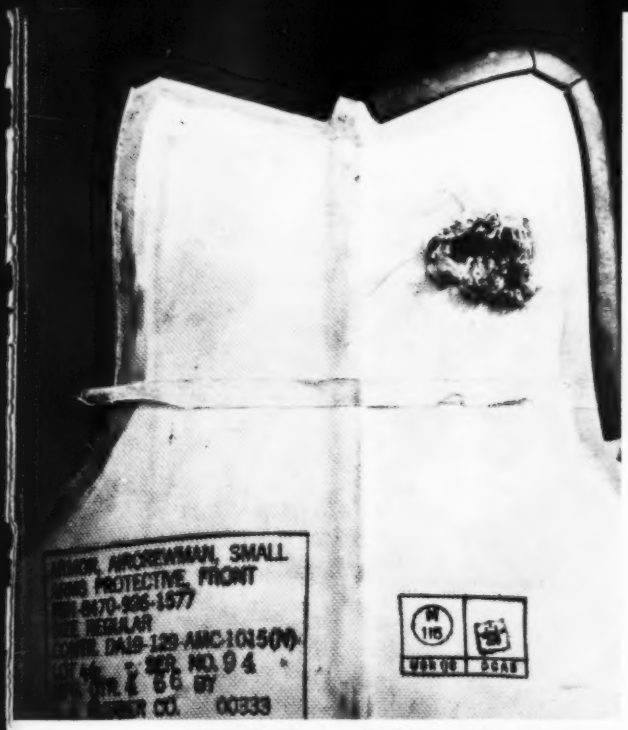
The heart of the system safety process is hazard analysis. When this process is applied to existing systems in mid-life cycle, the scope and detail of the hazard analysis must be limited for efficiency and economy. But, unless the analysis is broad and detailed enough, there is a strong possibility that corrective action will not solve problems and may give rise to other related problems. This key consideration must always be kept in mind: when mishaps are caused by component failures or malfunctions, modifications must be designed to prevent further mishaps, not just to prevent further failures. In other words, we are not nearly as concerned with the component failure itself as we are with the adverse consequences of such failure.

Perhaps the most significant conclusion is the reemphasis on integration of all assurance sciences. Again, this is nothing new. Major General G. F. Keeling and Mr. J. L. Maybell stated it well in their report, "Optimized System Engineering," in the 1969 Annals of Assurance Sciences. They said, "*Integration* means the timely and appropriate intermeshing of engineering efforts and disciplines to ensure their full influence on the system design and the technical program." Safety is but one part of product effectiveness. If product effectiveness is to be improved through improvements in safety, it can be accomplished efficiently only through integration with the other assurance disciplines.

REFERENCES

1. *Military Standard, MIL STD 882, "System Safety Program for Systems and Associated Subsystems and Equipment," June 1966.*
2. *Darrah, J. T., Jr., U. S. Army, "The System Safety Process," U. S. ARMY AVIATION DIGEST, May 1970.*
3. *Conrad, E. B., U. S. Army, "Design for the Man, Machine and Environment," paper presented at the DOD/Rand Corporation Symposium, Santa Monica, California, February 1970.*
4. *Keeling, G. F., USAF, and J. L. Maybell, "Optimized System Engineering," Moderator/Chairman report of the 8th Reliability/Maintainability Conference, p. 69, Denver, Colorado, July 1969.*
5. *U. S. Air Force Systems Command (AFSC) Design Handbook DH 1-6, "System Safety," Headquarters, AFSC, Andrews AFB, Washington, D. C.*

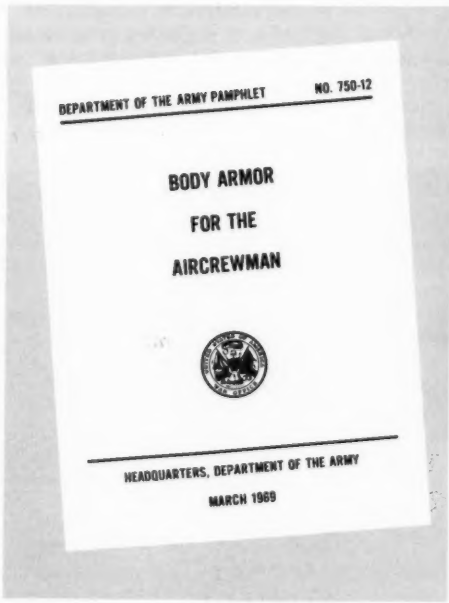
PEARL'S
personal equipment and rescue/survival lowdown



SP4 Robert Byrd, medic, 571st Med Det (HA), was on an urgent medical evacuation when his helicopter came under intense enemy fire from small arms and automatic weapons. He was struck by two projectiles at the same time, knocking him to the floor. One round hit his extended left arm and the other hit his front armor plate at the upper left corner of the pocket, but did not penetrate the armor plate. SP4 Byrd was evacuated home, a very lucky man. If he had not been wearing his armor plate, the second projectile would have penetrated his heart

BODY ARMOR

CONVERSATIONS with air crew members returning from Southeast Asia indicate everyone has seen, heard of or used personal body armor, but very few report having seen DA Pamphlet 750-12, "Body Armor for the Aircrewman." The cover of this informative little pamphlet is shown for those who have not seen it. I strongly recommend you get a personal copy and some copies of DA Form 3468, "Record of Hit." Only through the submission of accurate information from the field can people who design and manufacture body armor provide the best possible protection for you. If the armor is doing the job it was designed to do, they want to know about it. If it is not doing its job, they must know about it to make improvements. See the photographs on this page for evidence of what body armor can do for you if you wear it properly.


DEPARTMENT OF THE ARMY PAMPHLET NO. 750-12

BODY ARMOR
FOR THE
AIRCREWMAN

HEADQUARTERS, DEPARTMENT OF THE ARMY
MARCH 1969

PFC Gerald Schindler, 283rd Med Det (HA), was on a medical evacuation mission when his helicopter came under enemy fire. He was struck in the middle of his back by two projectiles believed to be from an AK-47 Communist assault rifle. The projectiles did not fully penetrate the body armor back he was wearing and he sustained only minor first degree friction burns and bruises

USAASO Sez

The U. S. Army Aeronautical Services Office discusses

Air Navigation Outages Statistics

It All Starts Here: COPILOT TO PILOT: "C+X!= fair weather GCA just went off the air again—just when we need it most!"

PILOT TO COPILOT: "How about the VOR?"

COPILOT TO PILOT: "Sir, are you kidding? About 3 months ago it was removed from commissioned status because of unreliability. The identifier is disconnected but we can still use it."

PILOT TO COPILOT: "Go ahead and monitor it, but let's make the old reliable beacon approach if the weather has lifted. Seems as though we have had more practice on that anyway."

COPILOT TO TOWER: "Creaky tower, this is Army 66699. GCA is out and we would like to try a beacon approach. We're holding over the Hope beacon at 3,000 feet. What's the latest weather?"

- silence -

COPILOT TO TOWER: "Creaky tower, this is Army 699. Do you read?"

TOWER TO 699: "Garble-garble, hell . . . o . . . o . . . hel . . . Arm . . . 6 . . . ahead . . . garble. . . ."

ARMY 699 TO TOWER: "We'd like to make, etc."

Air navigation outage statistics prove that this dialogical sequence could have taken place a number of times and at a number of our major airfields over the past year. It is understandable for an airfield commander to have aircraft operational readiness foremost in his mind. What is not understandable is why some airfields, year after year, fail to make progress in establishing reliable ATC facilities. It appears that it's largely the old story about the squeaking wheel and the grease. Review of success stories (and there are a few) on operation of Army ATC facilities revealed, in all cases, that an extremely aggressive airfield commander had been at the helm. Herein lies the choice of our title, "It All Starts Here."

The U. S. Army Aeronautical Services Office gives airfield commanders guidance for maintenance and modernization of air traffic control facilities. All the Army regulations, technical bulletins, manuals and guidance aren't going to accomplish a "hoot" without a well-defined and well-sold upgrading program tailored to the mission of your particular airfield. The following steps, diligently pursued, are guaranteed to help you get it started at your airfield.

• *Review AR 95-9* . . . AR 95-9 (Terminal Air Navigation and Air Traffic Control Facilities and Procedures—November 1969) should be reviewed to understand the basis for classification of your airfield. Airfield classification is based on your mission and traffic density and establishes what facilities/procedures you should have to do a professional job of air traffic control. The AR, in effect, gives guidance to establish justification for facilities. Check the new classification for your airfield, which appears in the current DA Circulars 95-19 (CONUS), 95-20 (USAREUR) or 95-21 (USARPAC), to assure that it reflects your mission requirements and, if appropriate, take steps in accordance with AR 95-9 to change the classification.

• *Review TB 95-1* . . . Determine from TB 95-1 (U. S. Army Air Traffic Control and Navaid Facility Standards) what type of construction and equipment is necessary to conduct your mission. TB 95-1 installation standards include criteria for standard high density tower, low density tower, communications transmitter facility, GCA facility, VOR facility, radio beacon facility, airfield operations communications and others. This TB includes a recommended BOI for ATC equipment.

• *Determine MCA requirements* . . . Requirements (with strong and detailed justification) for construction, such as a control tower or a transmitter communications building, will be submitted by the Installation Planning Board for inclusion in an MCA program. Selling the planning board on a high MCA priority for requirements now becomes the "name of the game" since there are always more MCA requirements than MCA funds. Also, it is anticipated that this unsatisfactory MCA condition may become more acute in the future. The success of this step is obviously directly related to the aggressiveness of the airfield commander.

• *Write your own success story!* Provide your airfield with the best air traffic control program in the Army. Take the first step!

U. S. Army Aviation Museum

The United States Army Aviation Museum at Ft. Rucker, Ala., has special exhibits periodically on display to commemorate various current events or special interest subjects.

The current special exhibit is of the Presidential Flight Detachment. The majority of items in the display belong to the personal collection of Lieutenant Colonel William A. Howell (USA, retired), the director-curator of the museum, who was the first commanding officer of the detachment.

Recent additions to the exhibit were donated by the Presidential Flight Detachment. Lieutenant Colonel Gene Boyer, the present commanding officer of the detachment (on the right), presents one of two pictures of President John F. Kennedy with "Army One" to Major General Allen M. Burdett, commandant of the U. S. Army Aviation School. The museum is open to the public from 0900 to 1600 hours weekdays and 1300 to 1700 hours weekends and holidays. Closed Christmas day.

CW4 Paul L. Pagano
Aircraft Accident Review and Analysis Dept.
USABAAR

RECIPE FOR THE MONTH

How To Make a Crash Facts Message

From a tried and proven recipe used many times, year after year . . .

TAKE ONE *aircraft:* any form of craft designed for flight through the air.

Take one tank of *fuel:* a combustible matter used as a source of energy.

Mix with one pilot who is *foolish:* marked by, or showing a lack of good sense, unwise.

Bring to a state of *exhaustion:* the condition of being completely deprived of valuable or useful elements.

Add a feeling of *letdown:* a decrease; slackening, as of speed, force, energy or disappointment.

Stir in a pinch of *helplessness:* unable to help oneself, without recourse to help.

Top with an urge for self-*preservation:* to keep in safety; protect from danger or harm; guard; to keep intact or unimpaired.

Garnish with a loss of *pride:* an undue sense of one's own superiority; honorable self-respect; personal dignity and worth.

Serve in a setting that is *humble:* to reduce the pride of; to lower in rank or dignity; unpretentious; meek.

When completed, recipe makes one crash facts message (reference AR 385-40).

Item 3—aircraft type: UH-1D.

Item 5—damage classification: forced landing.

Item 9—mission: training, VFR.

Item 10—phase of operation: normal cruise returning to airport.

Item 11—description of mishap: *engine stopped in flight due to fuel exhaustion.*

Note: Same recipe can also be used to create deaths, injuries and destroyed or damaged equipment. *Word definitions from Funk & Wagnalls*